Influence of Antecedent Streamflow Conditions on Detecting Trends in Biological Communities

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Background Information

USGS Surface-water Trends Team

- USGS NAWQA project of the NAWQ program

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Ecology sampling began in 1993

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Ecology sampling began in 1993

- Largest spatially distributed time-series bioassessment dataset in the U.S.

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Background Information

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- USGS NAWQA project of the NAWQ program

Ecology sampling began in 1993

- Largest spatially distributed time-series bioassessment dataset in the U.S.

Assess changes in diatom, fish, and invertebrate communities

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Background Information

Trend assessment

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Background Information

Trend assessment

- Reduce signal-to-noise ratio in the time series
- Enhance trend detection

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Background Information

In water-quality trend monitoring

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Background Information

In water-quality trend monitoring

- Time, discharge, and season

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Background Information

In water-quality trend monitoring

- Time, discharge, and season
- Reduce signal-to-noise

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Background Information

In water-quality trend monitoring

- Time, discharge, and season
- Reduce signal-to-noise
- Enhance the detection of changes in concentration over time

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Background Information

In water-quality trend monitoring

- Time, discharge, and season
- Reduce signal-to-noise
- Enhance the detection of changes in concentration over time

- WRTDS, SEAWAVE, and SEWAVE-Q models

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Sample at Base Flow Conditions

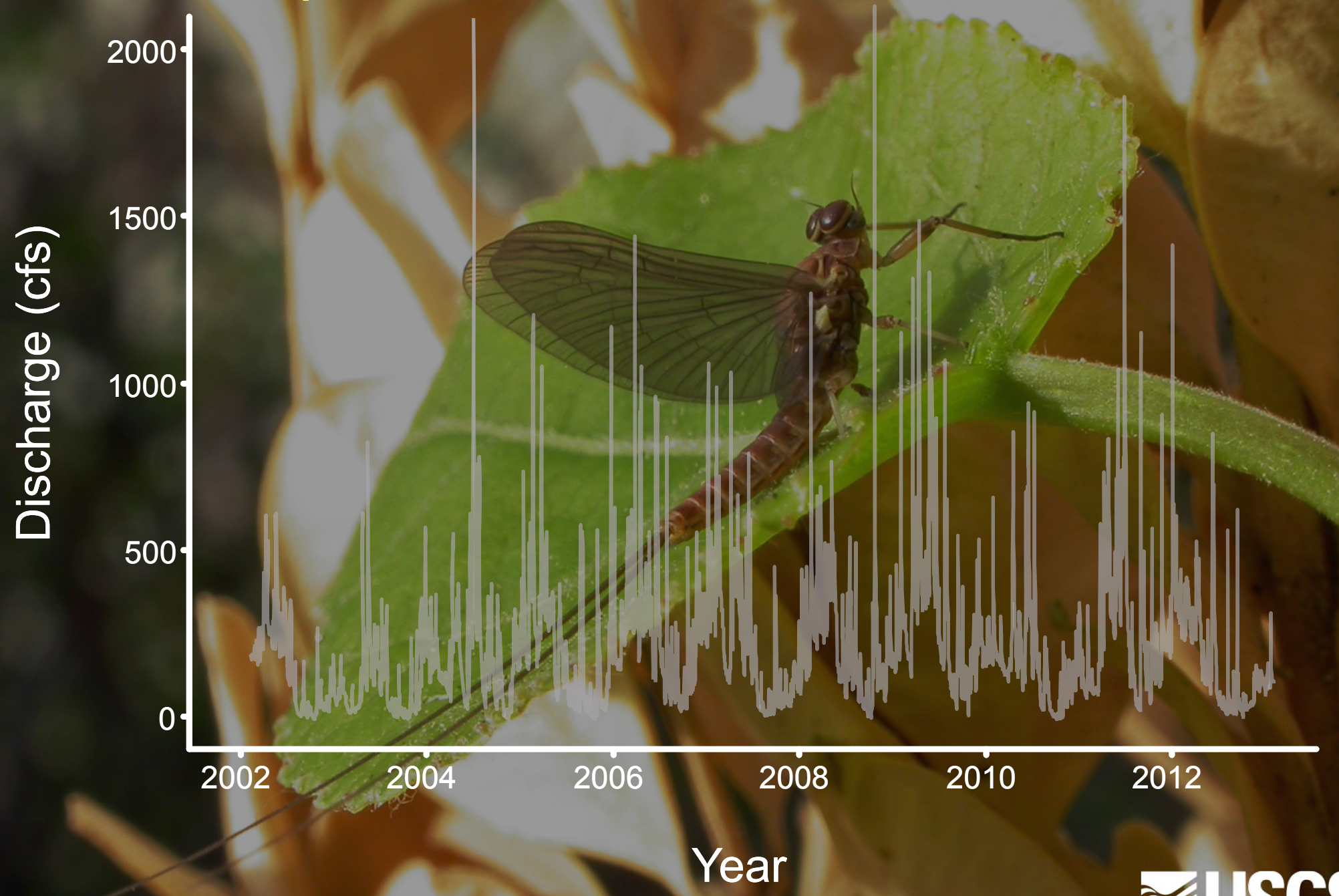

Photo (*Baetis magnus*, Cache la Poudre River, CO, Dave Rees)

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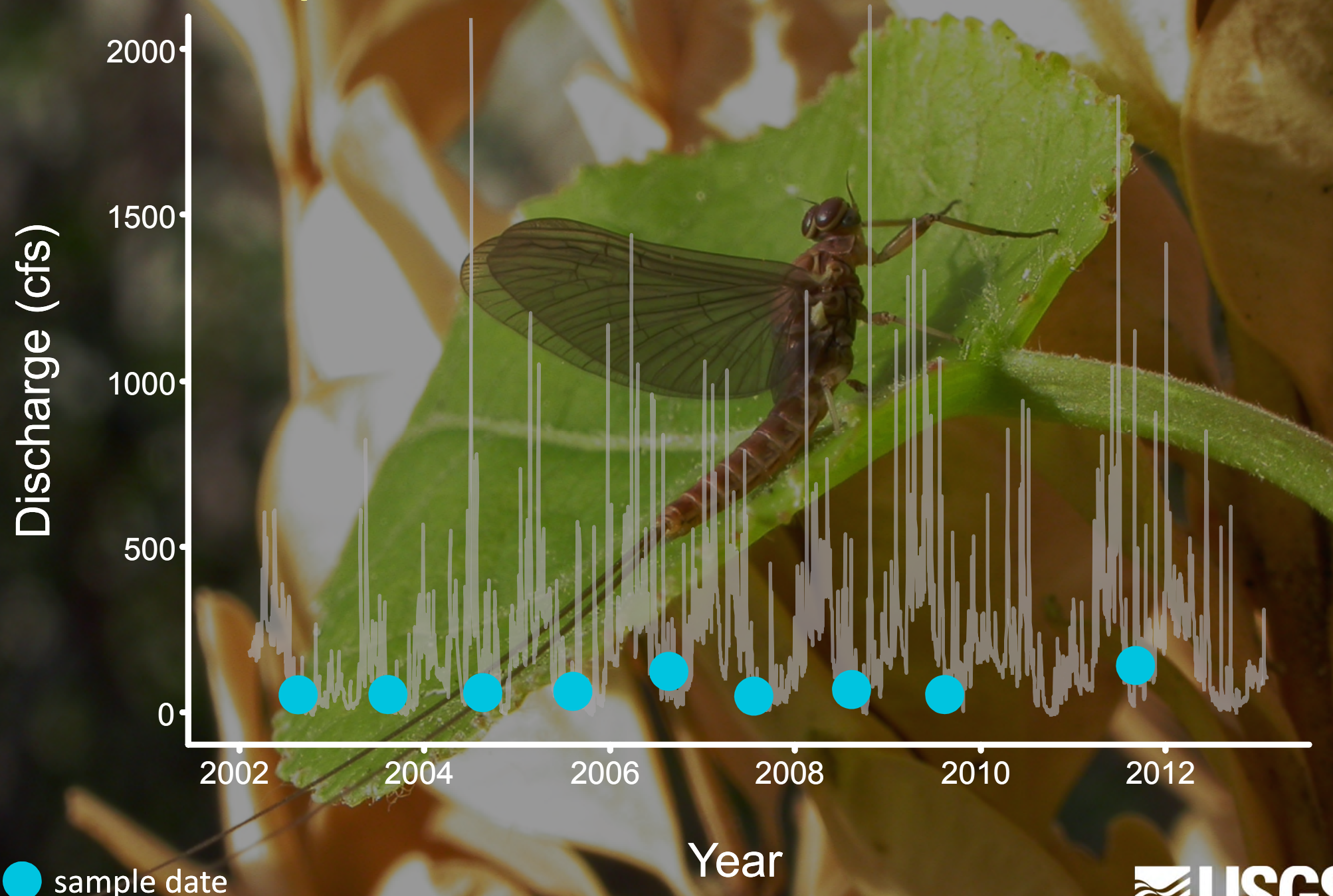
Sample at Base Flow Conditions



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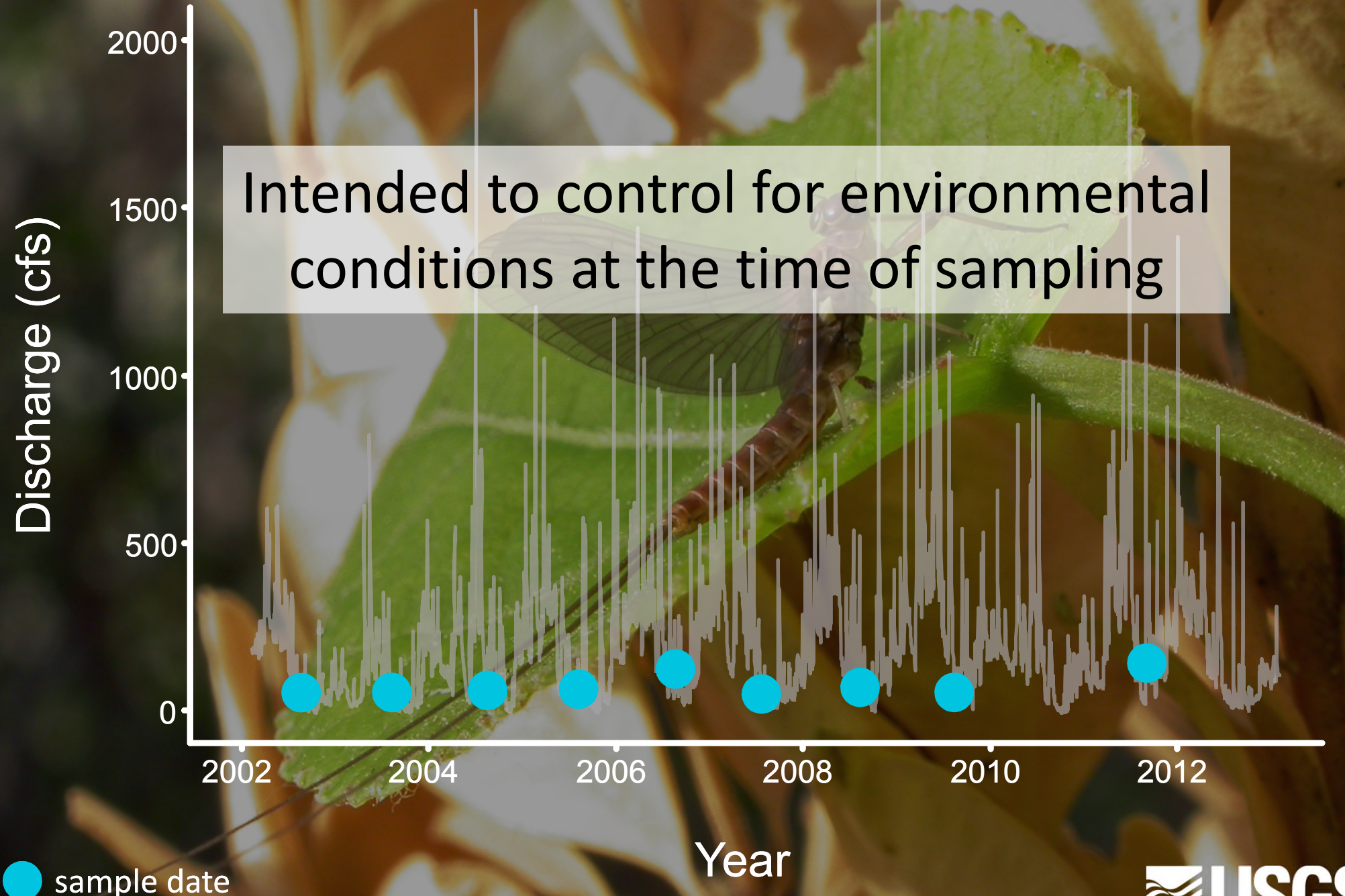
Sample at Base Flow Conditions



Intended to control for environmental conditions at the time of sampling

Photo (*Baetis magnus*, Cache la Poudre River, CO, Dave Rees)

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Year-to-year climatic conditions vary

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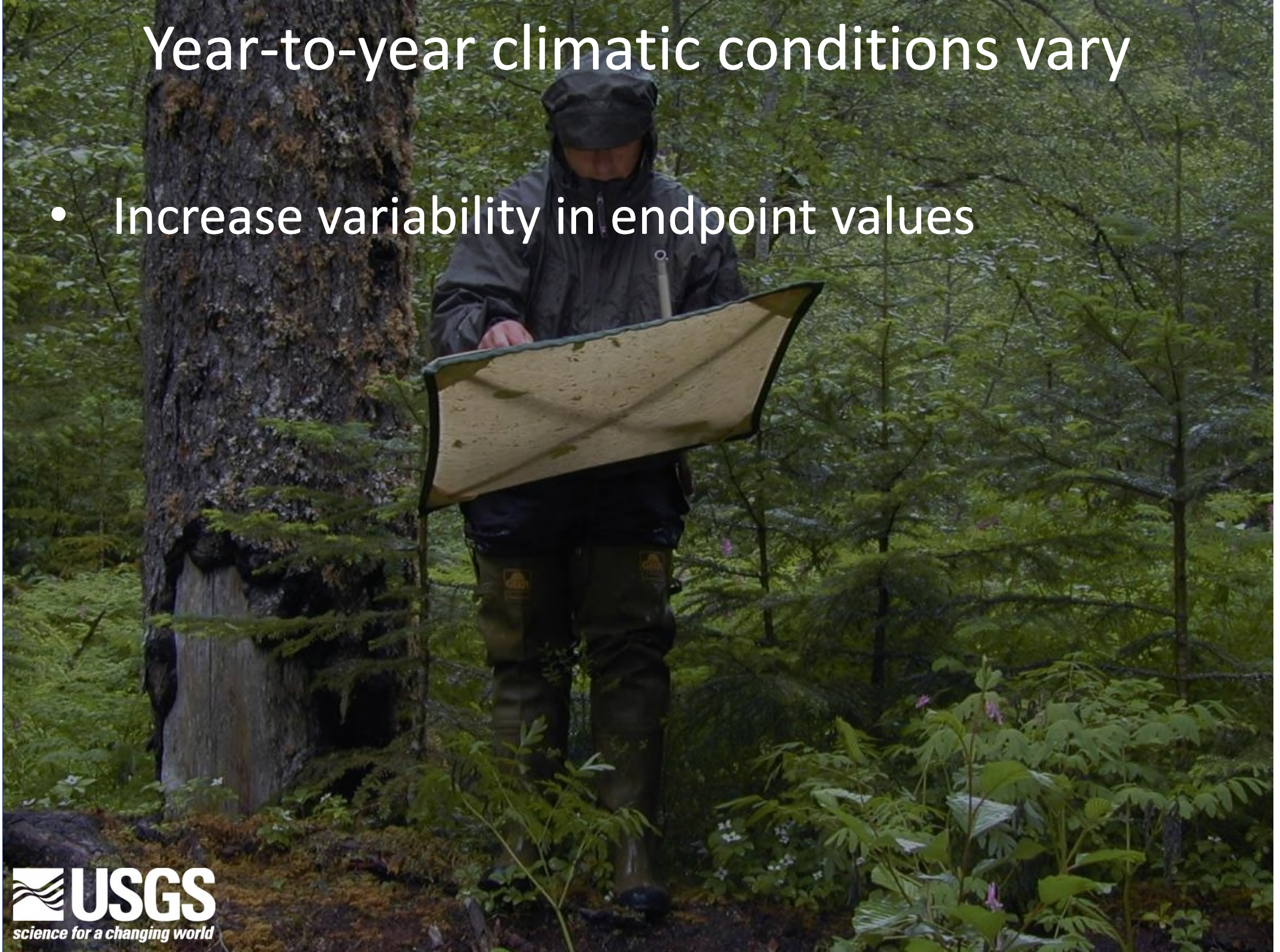
Year-to-year climatic conditions vary

- Increase variability in endpoint values



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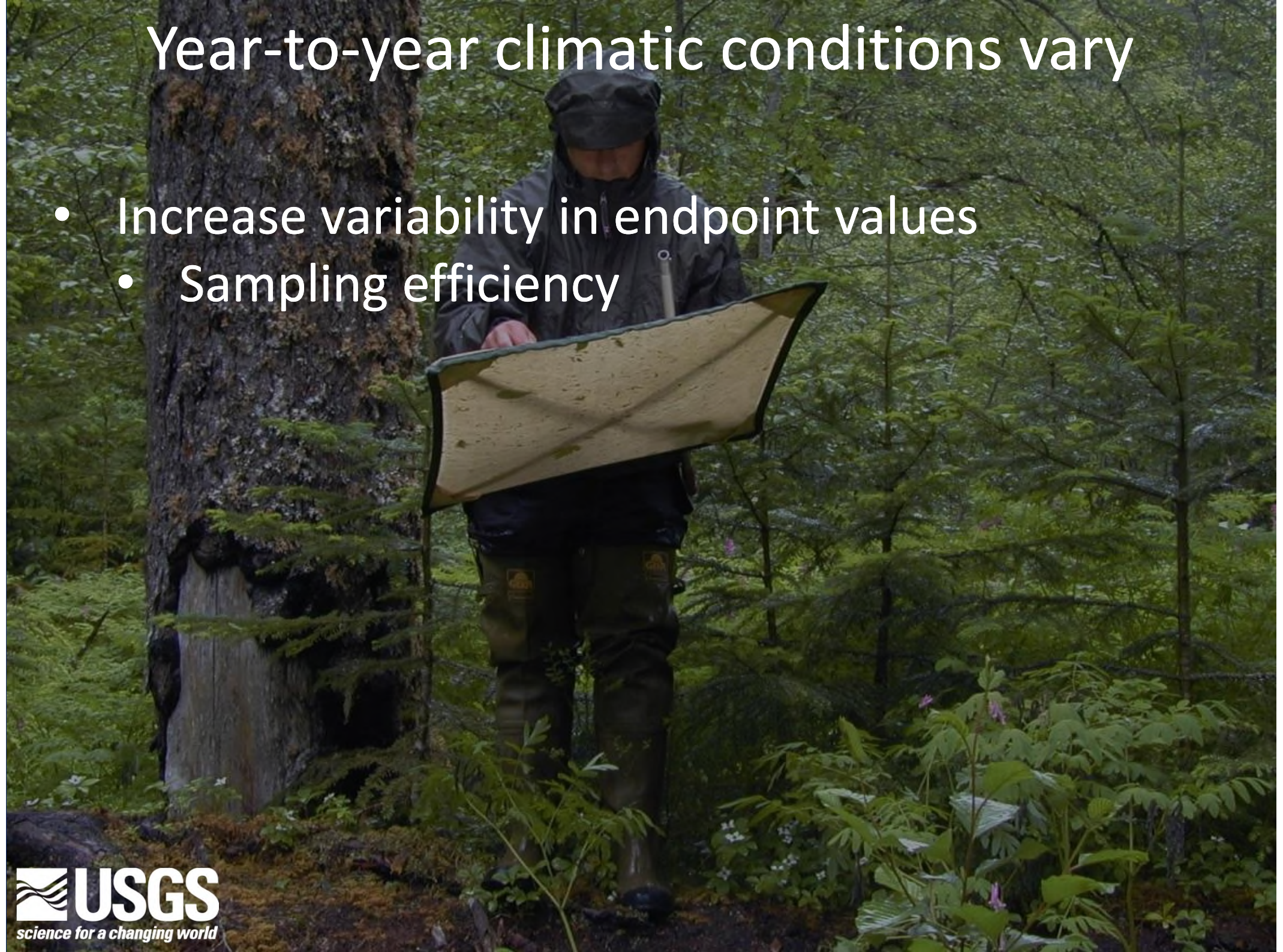
Year-to-year climatic conditions vary

- Increase variability in endpoint values
  - Sampling efficiency



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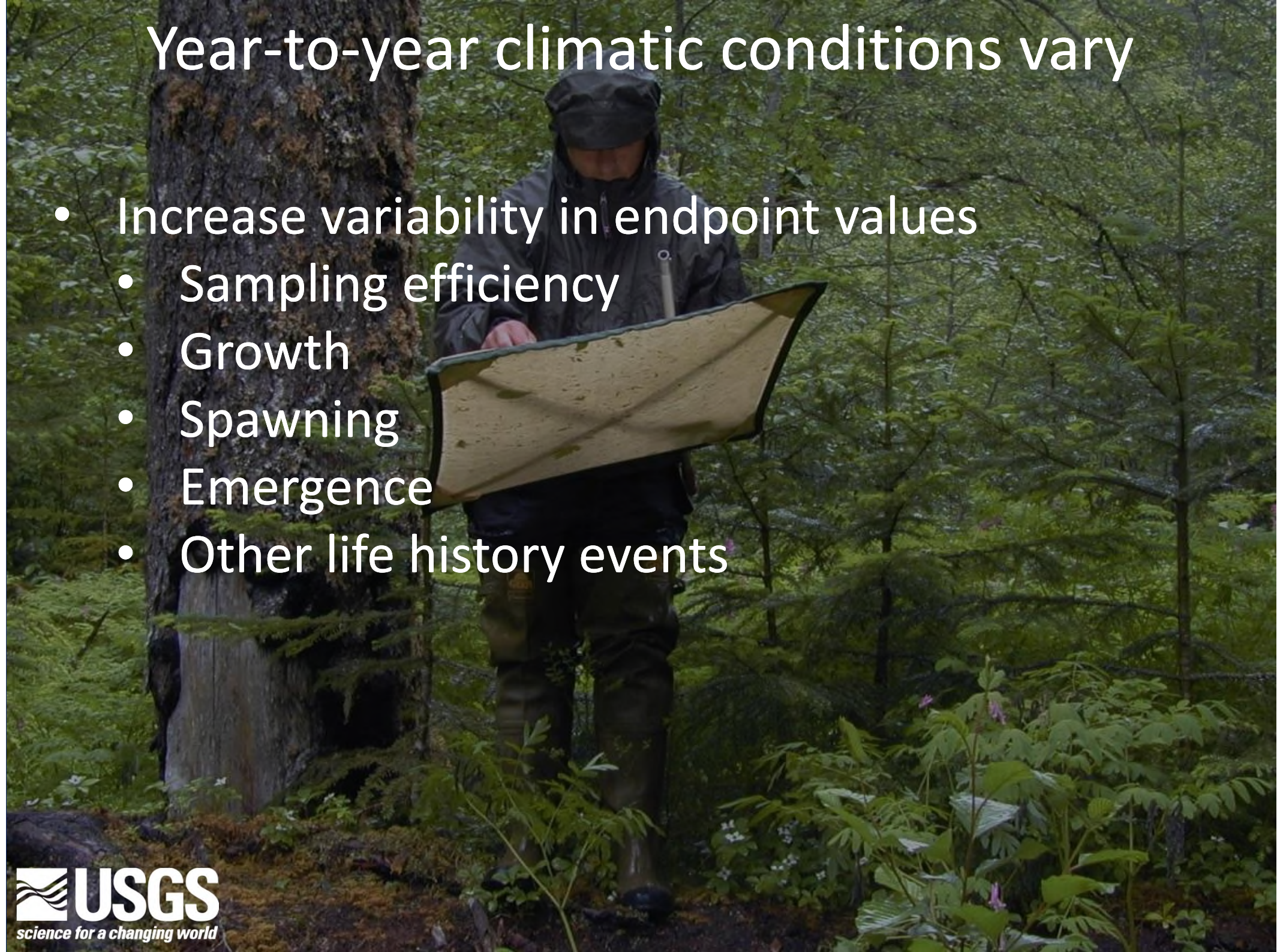
Year-to-year climatic conditions vary



- Increase variability in endpoint values
  - Sampling efficiency
  - Growth
  - Spawning
  - Emergence
  - Other life history events

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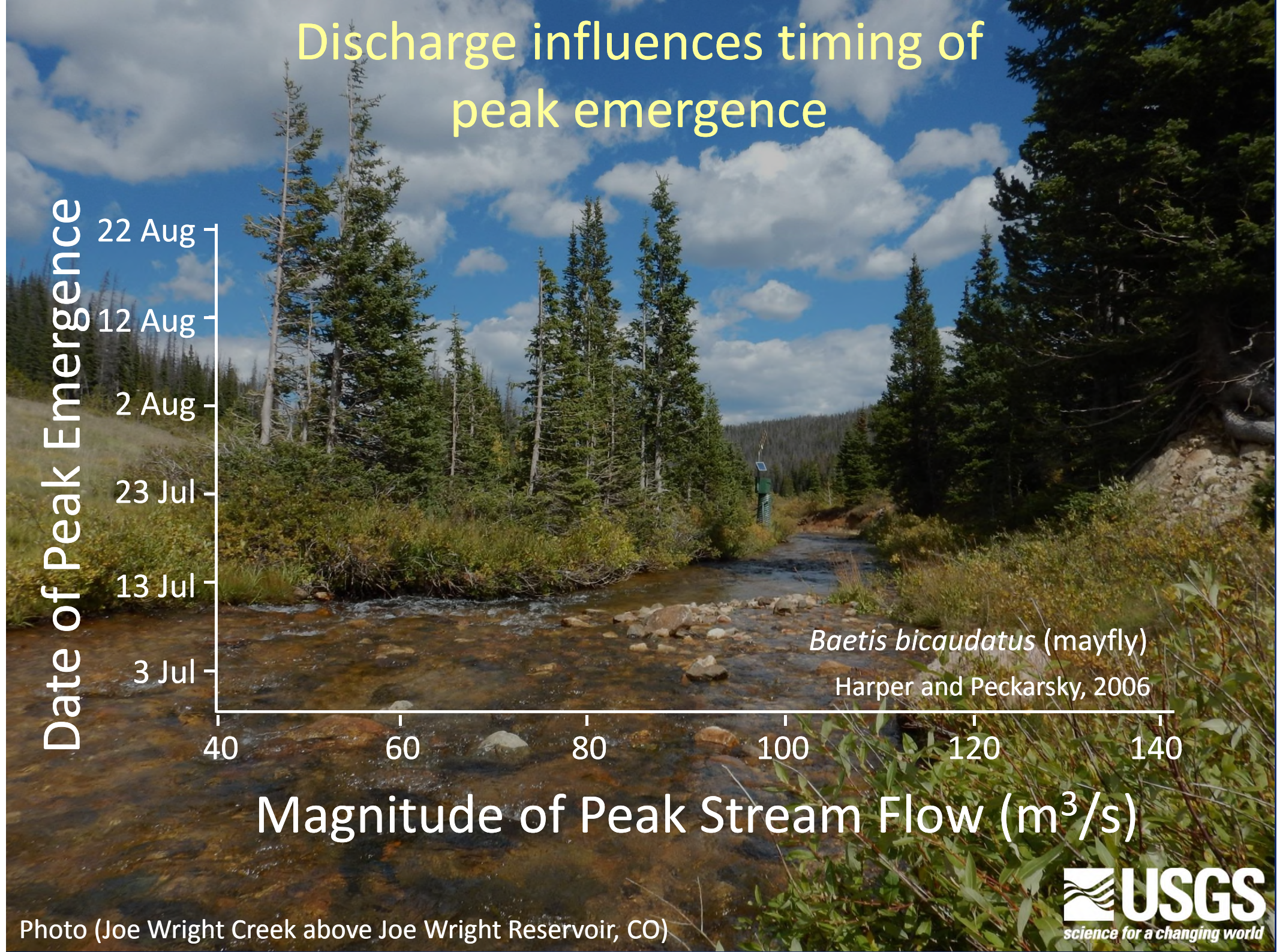
Discharge influences timing of peak emergence
Date of Peak Emergence
22 Aug
12 Aug
2 Aug
23 Jul
13 Jul
3 Jul
40
60
80
100
120
140
Magnitude of Peak Stream Flow (m³/s)
Baetis bicaudatus (mayfly)
Harper and Peckarsky, 2006
Photo (Joe Wright Creek above Joe Wright Reservoir, CO)
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Discharge influences timing of peak emergence cont.

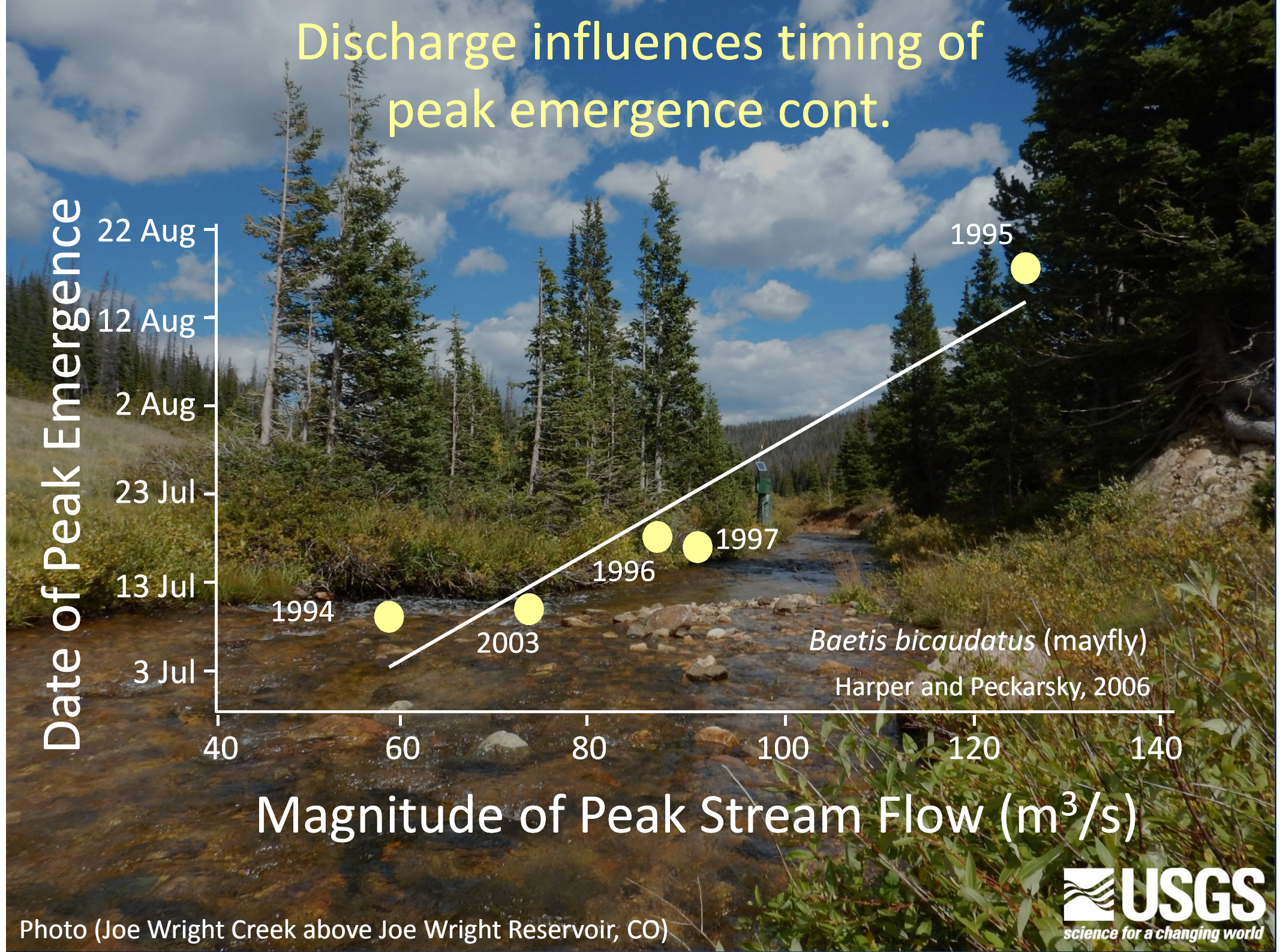

Photo (Joe Wright Creek above Joe Wright Reservoir, CO)

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Discharge influences timing of peak emergence cont.

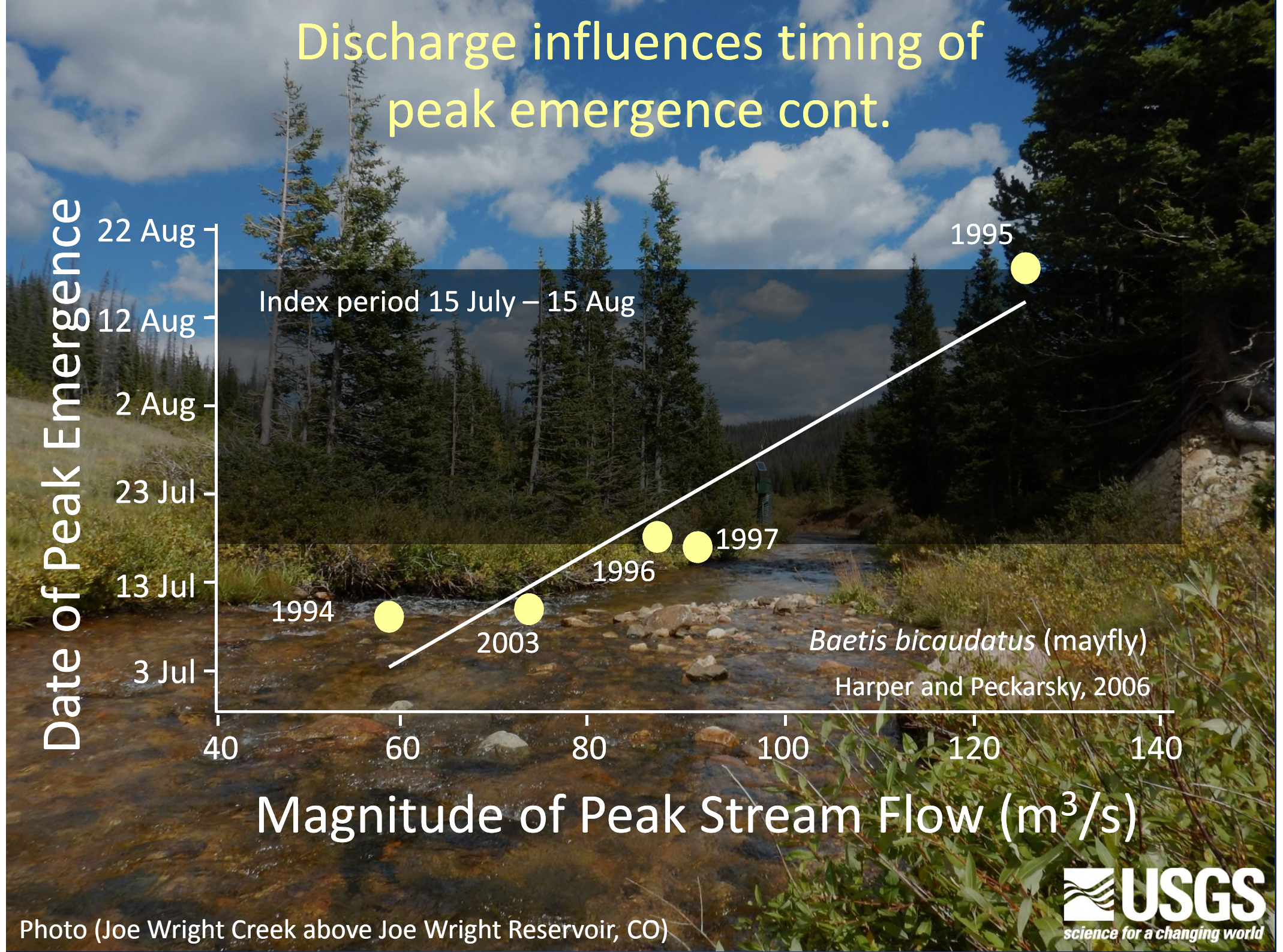

Photo (Joe Wright Creek above Joe Wright Reservoir, CO)

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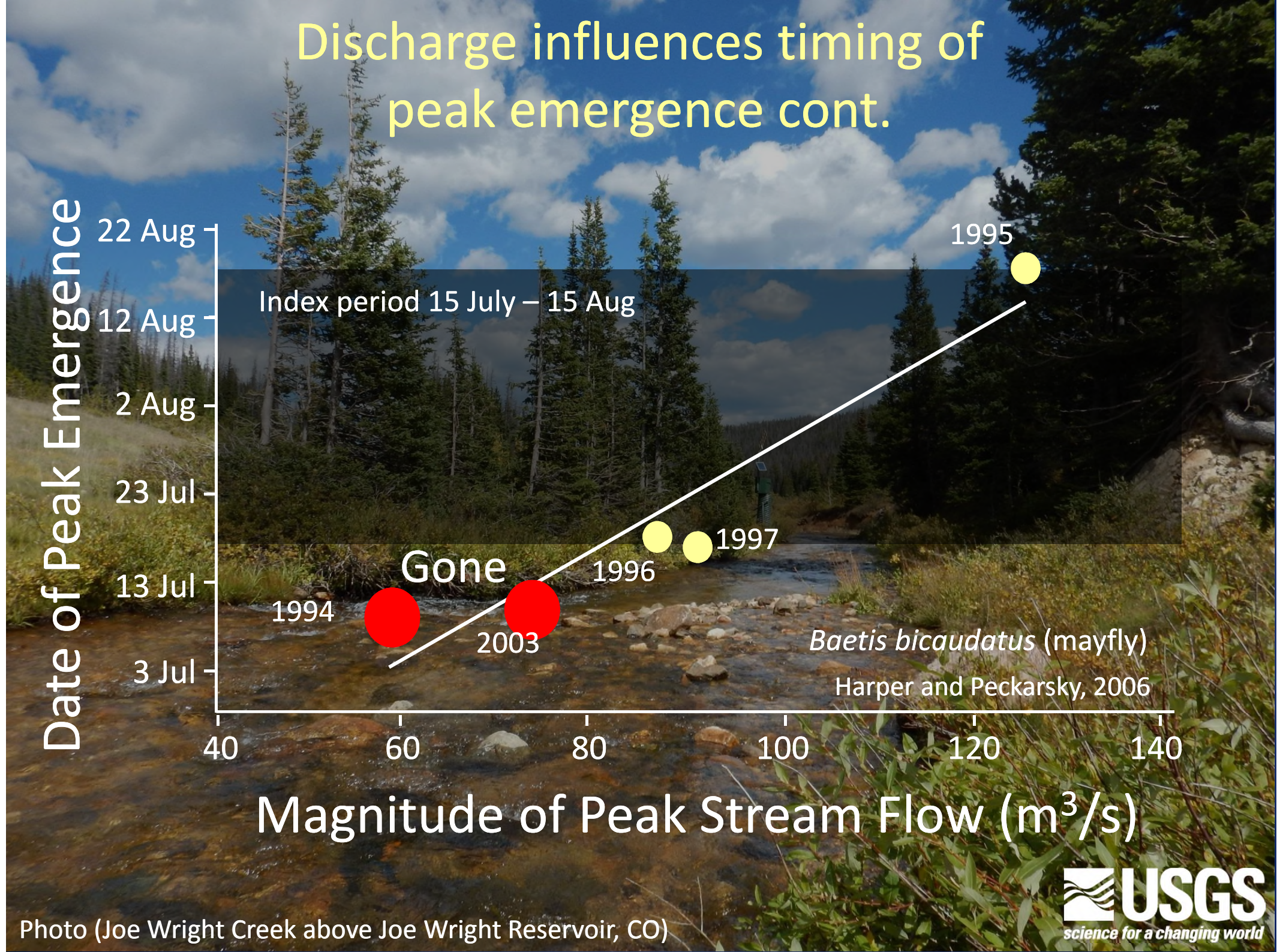
Discharge influences timing of peak emergence cont.



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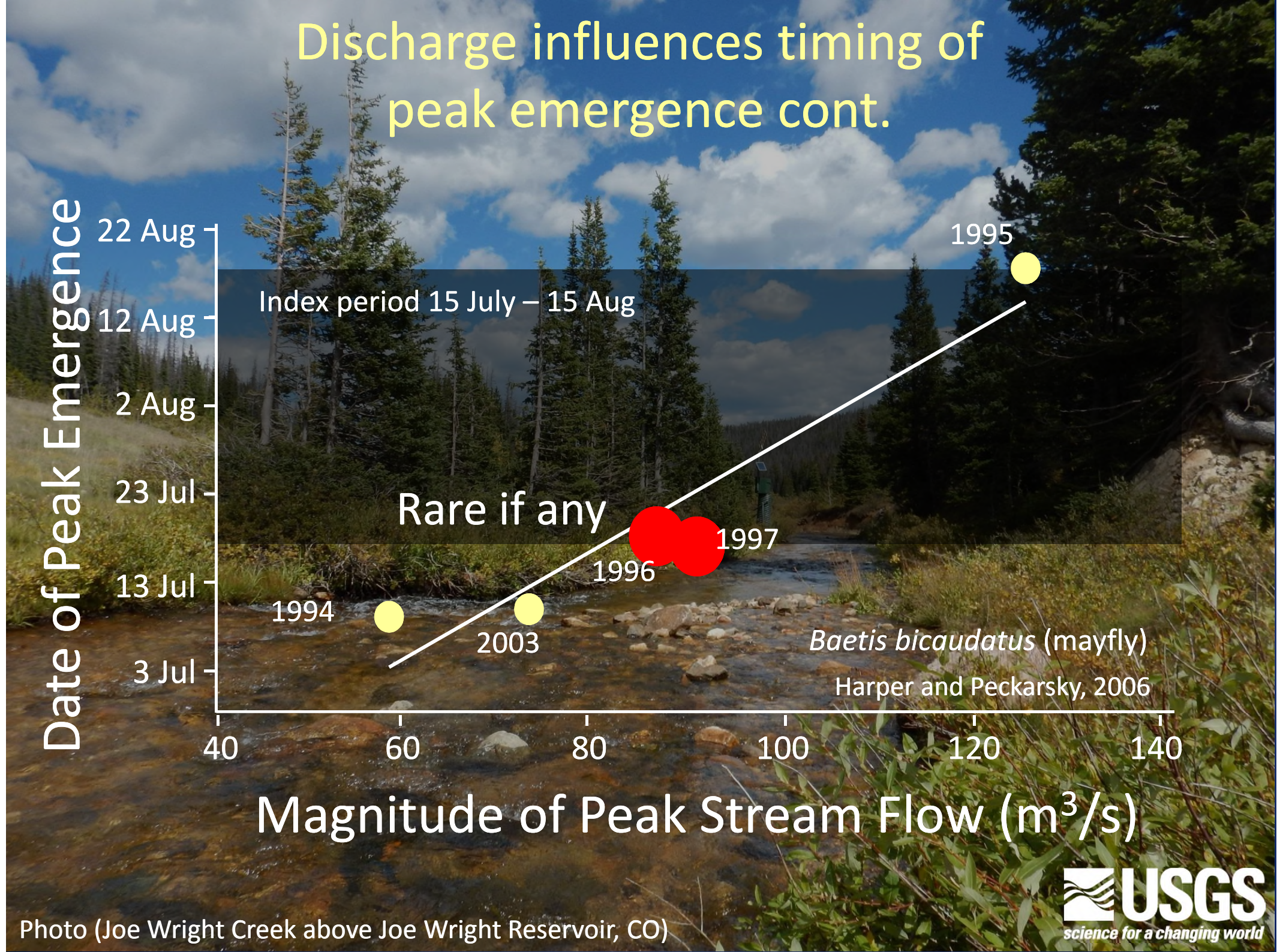
Discharge influences timing of peak emergence cont.



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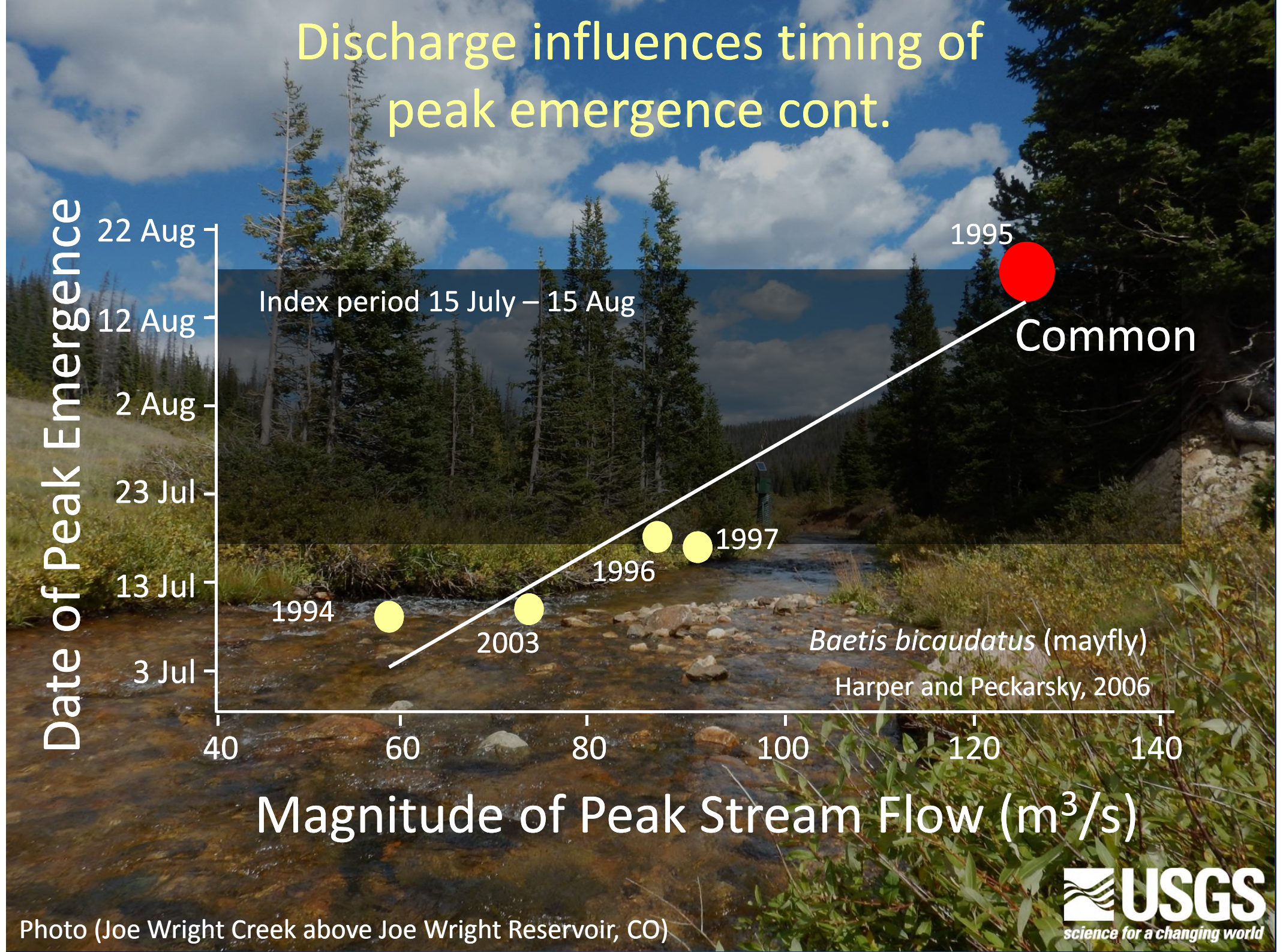
Discharge influences timing of peak emergence cont.



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Detecting Trends

Goal: reduce signal-to-noise

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Detecting Trends

Goal: reduce signal-to-noise

- Accounting for climate induced variability in endpoints (antecedent flow, temperature)

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Detecting Trends

Goal: reduce signal-to-noise

- Accounting for climate induced variability in endpoints (antecedent flow, temperature)
  - To isolate trends influenced by non-climatic factors

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Accounting for Endpoint Variability

Climate variables

- Streamflow
  - Average daily and coefficient of variation
  - Flows 15, 60, & 240 days *Antecedent* to each sample date

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Accounting for Endpoint Variability cont.

Climate variables

- Streamflow
  - Average daily and coefficient of variation
  - Flows 15, 60, & 240 days *Antecedent* to each sample date

- Air temperature
  - PRISM data
  - Average monthly temperature
    - sample month and 2 months prior

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Accounting for Endpoint Variability cont.

Biological Endpoints

- Measures of composition, similarity, diversity, tolerance, assessment indicators

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Putting it together

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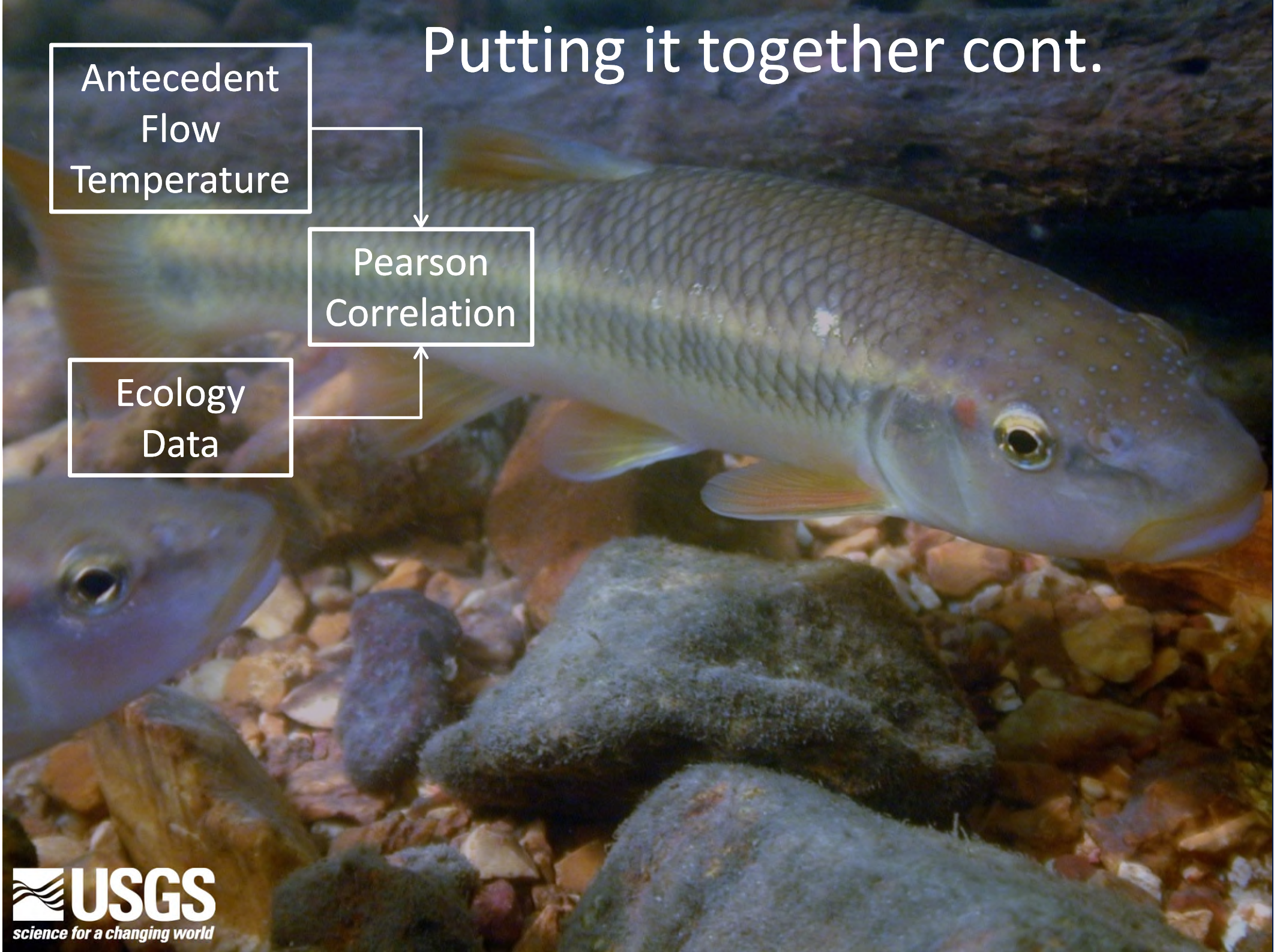
Putting it together cont.



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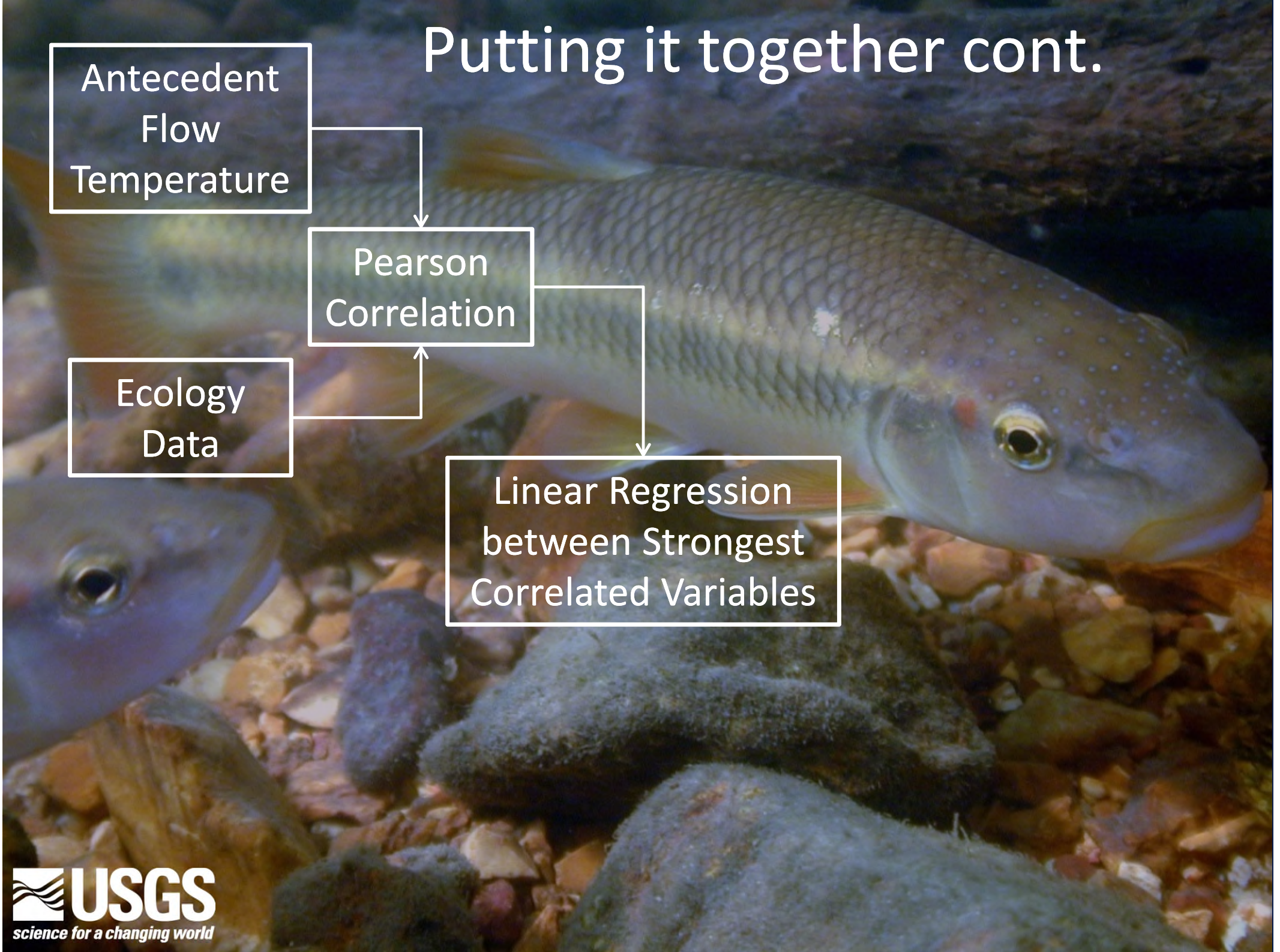
Putting it together cont.



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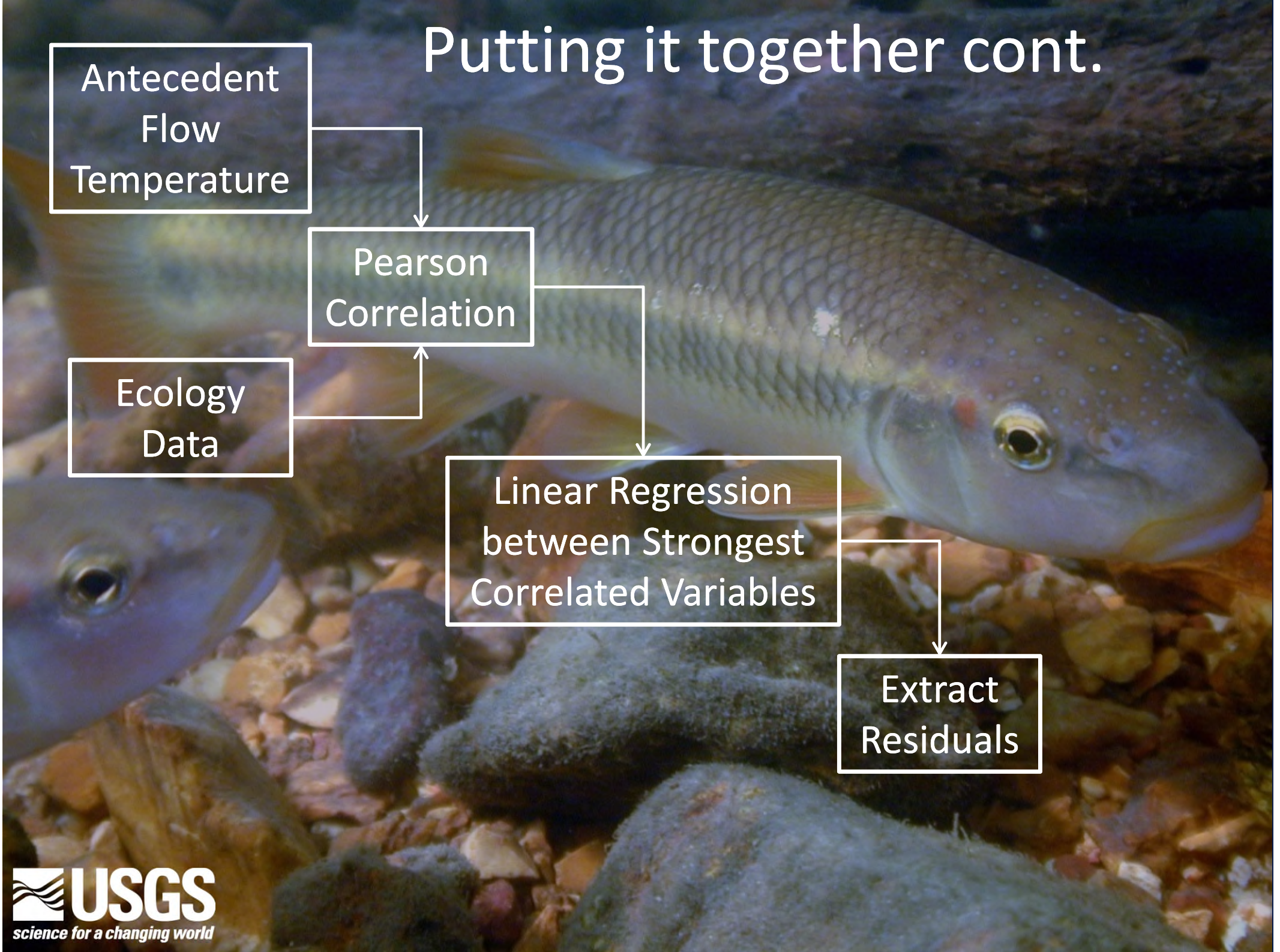
Putting it together cont.



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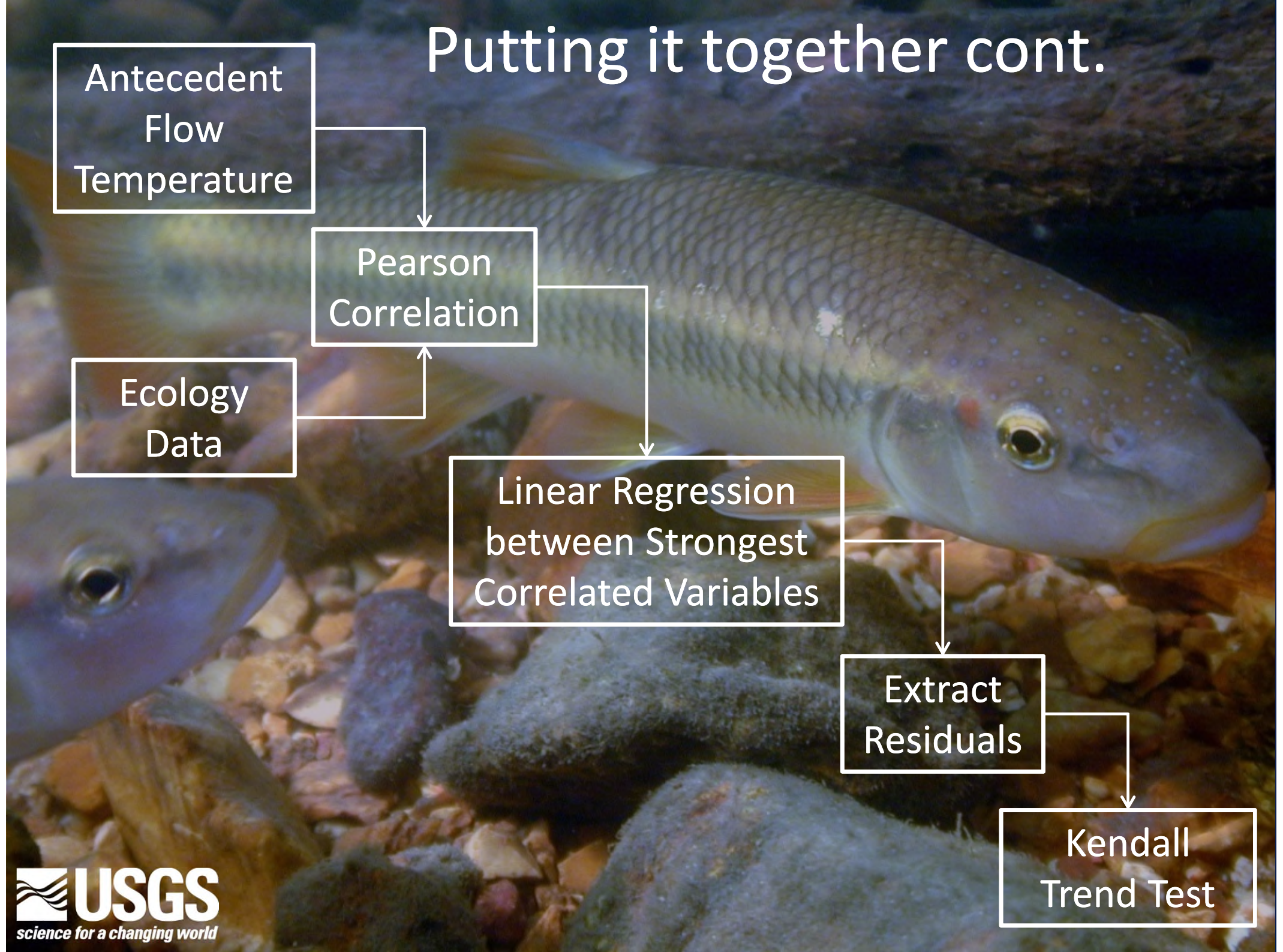
Putting it together cont.



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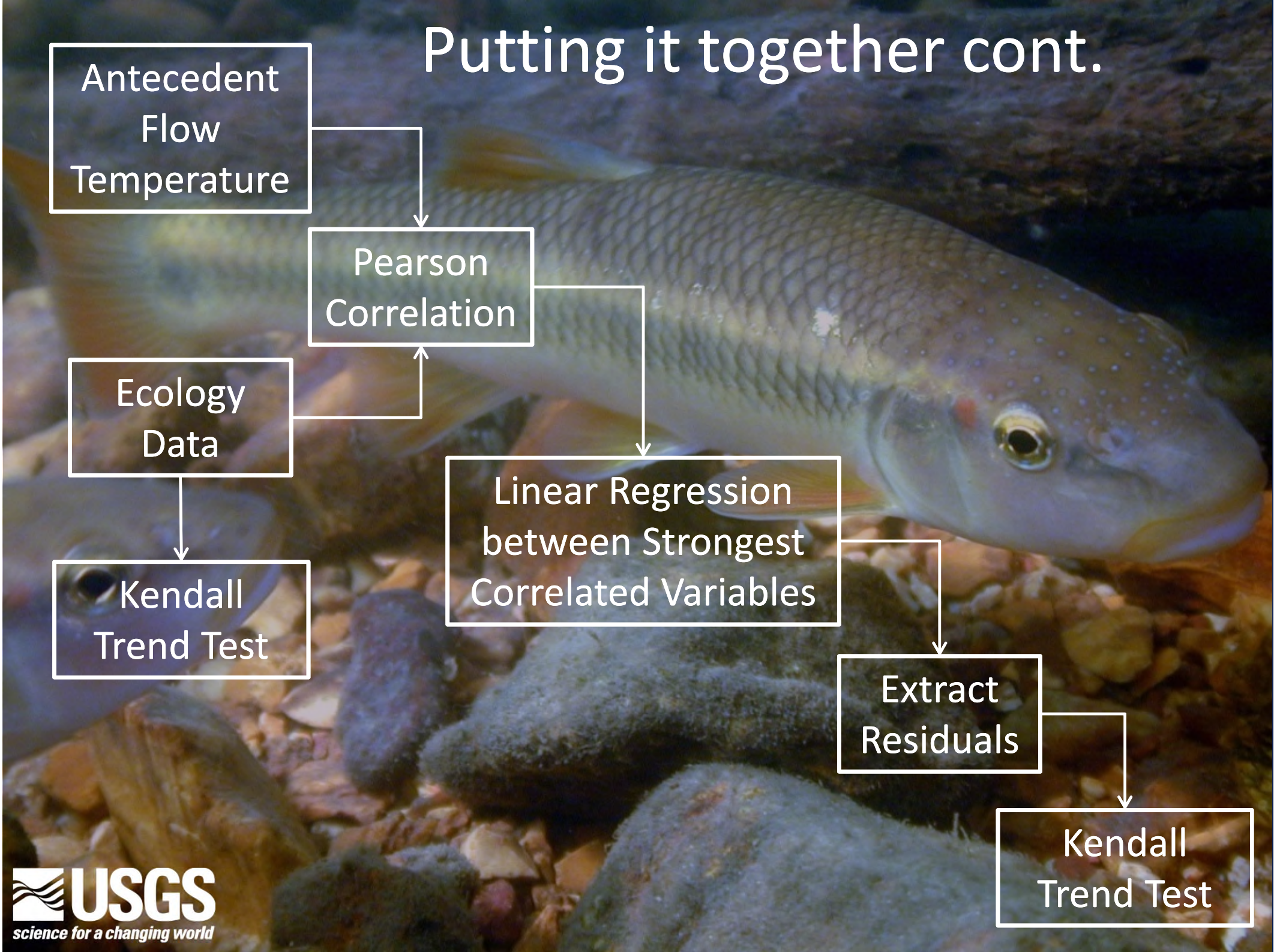
Putting it together cont.



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Antecedent Flow Example

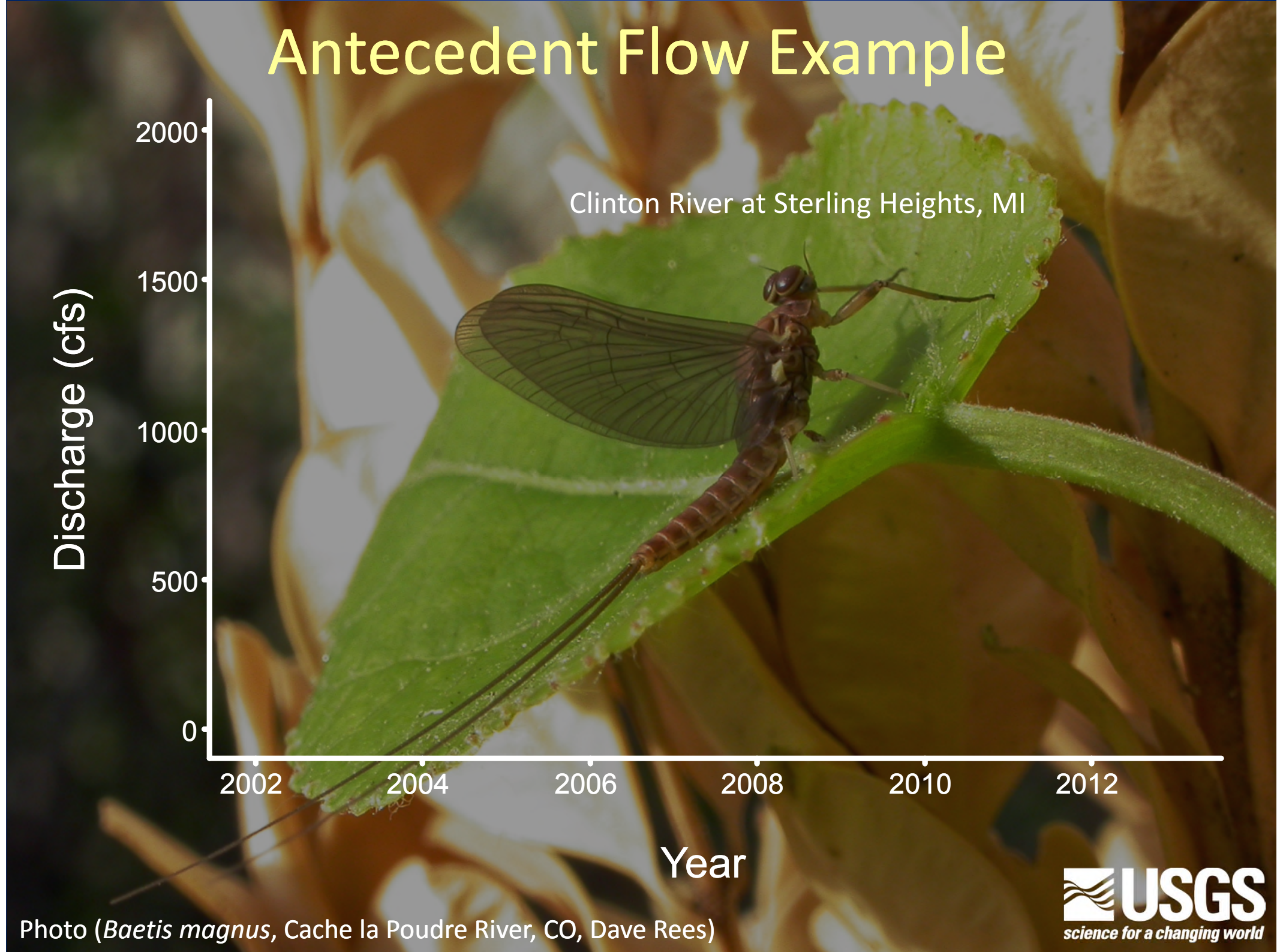

Photo (*Baetis magnus*, Cache la Poudre River, CO, Dave Rees)

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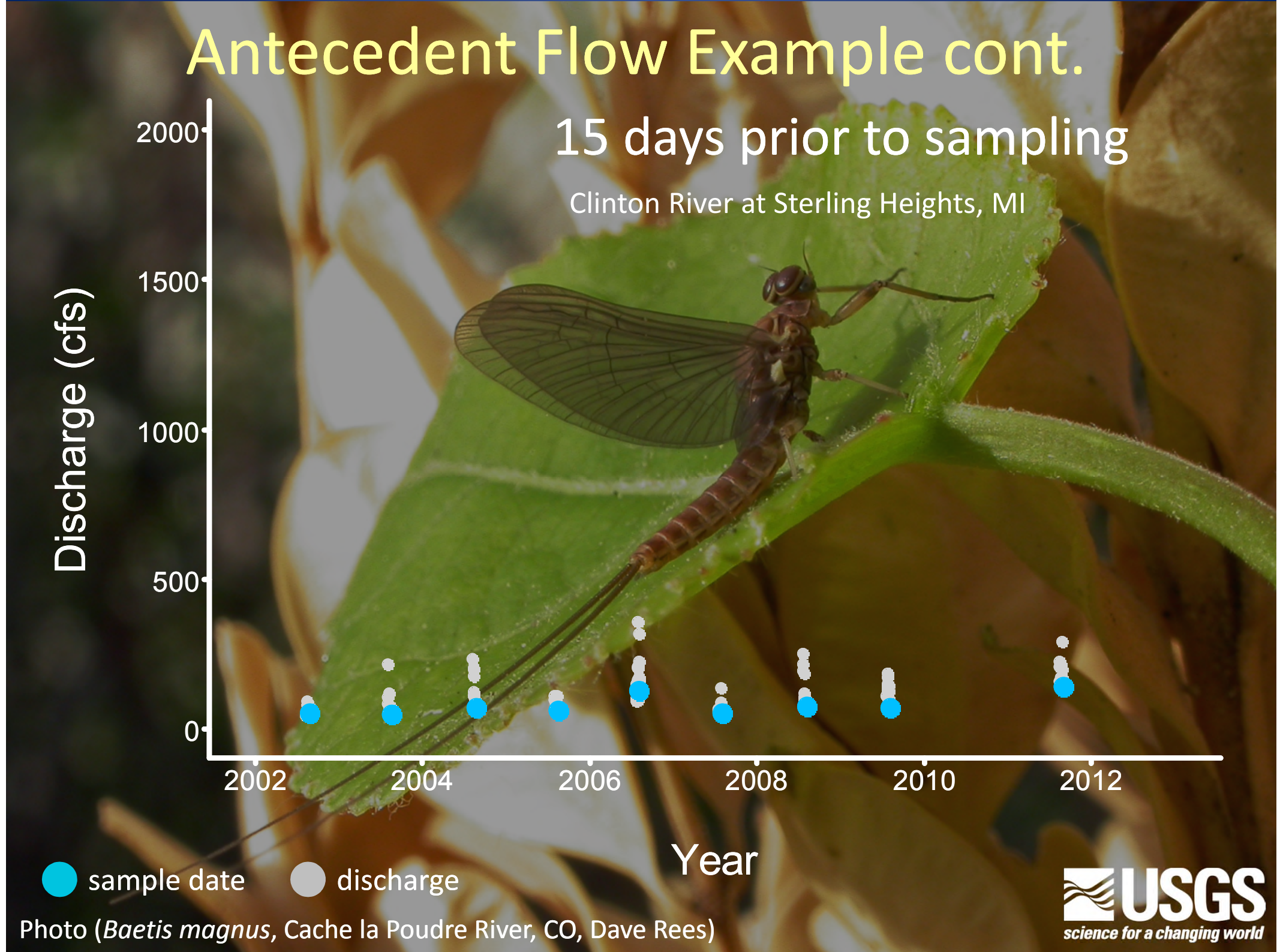
Antecedent Flow Example cont.



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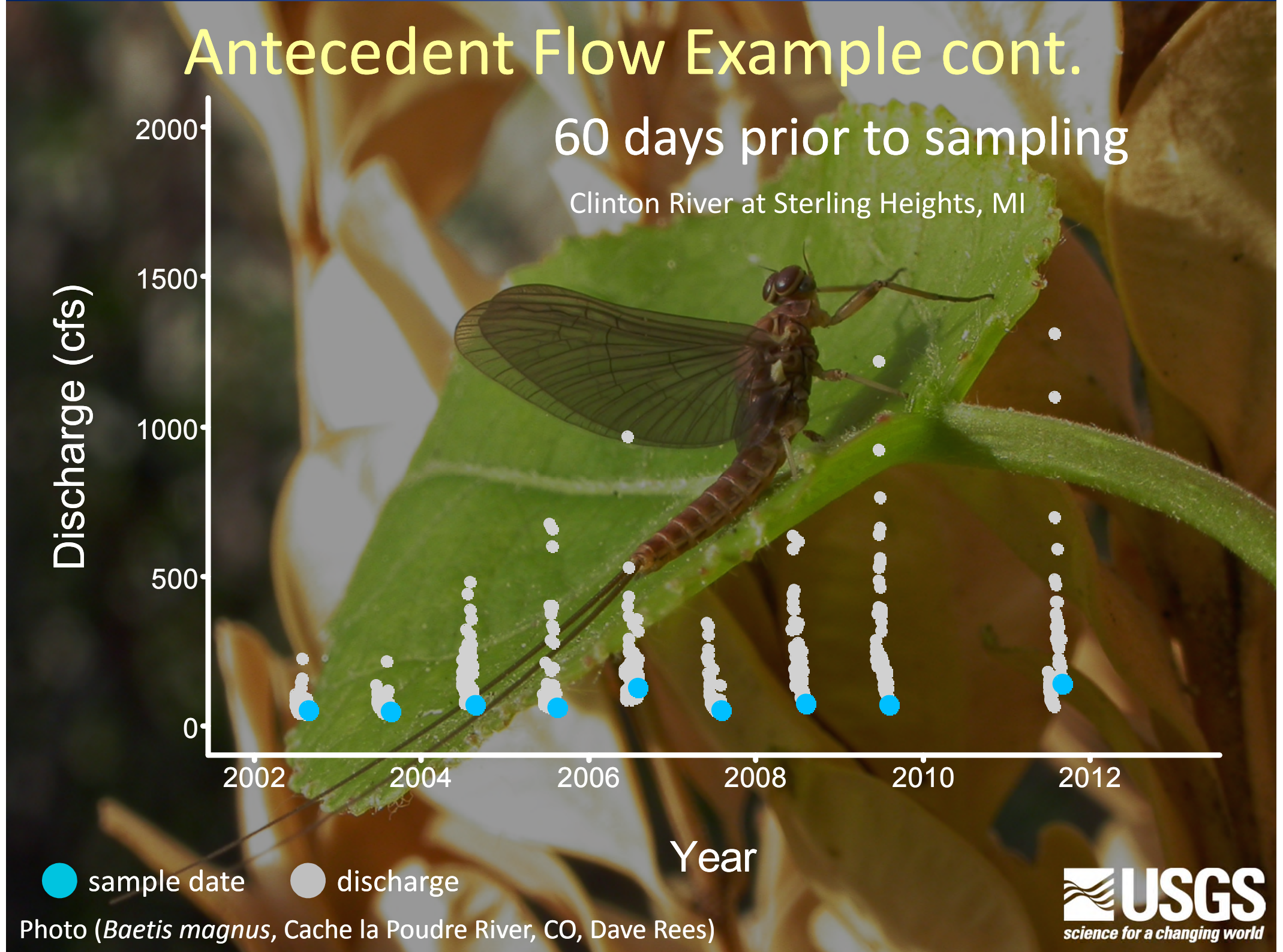
Antecedent Flow Example cont.



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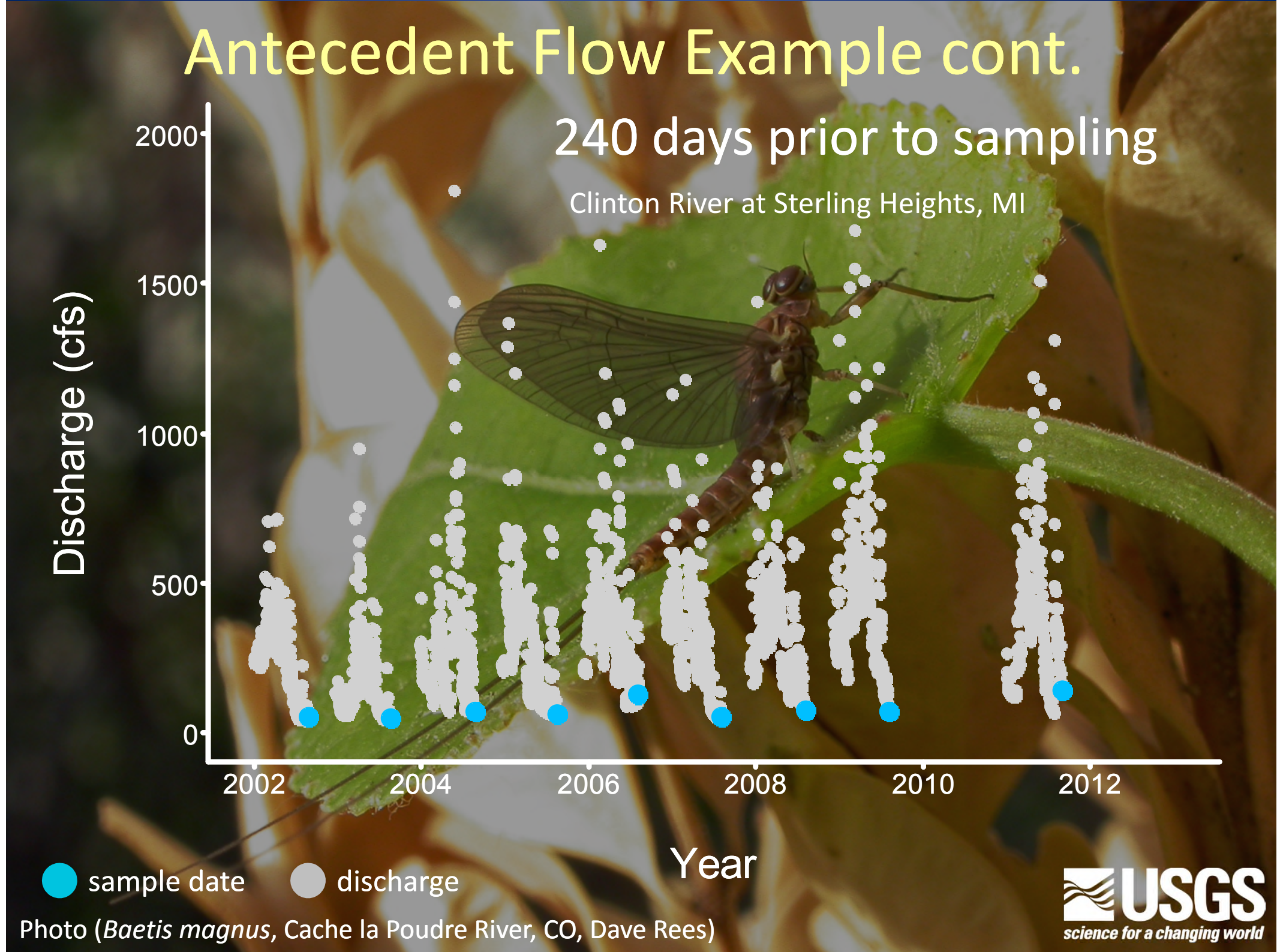
Antecedent Flow Example cont.



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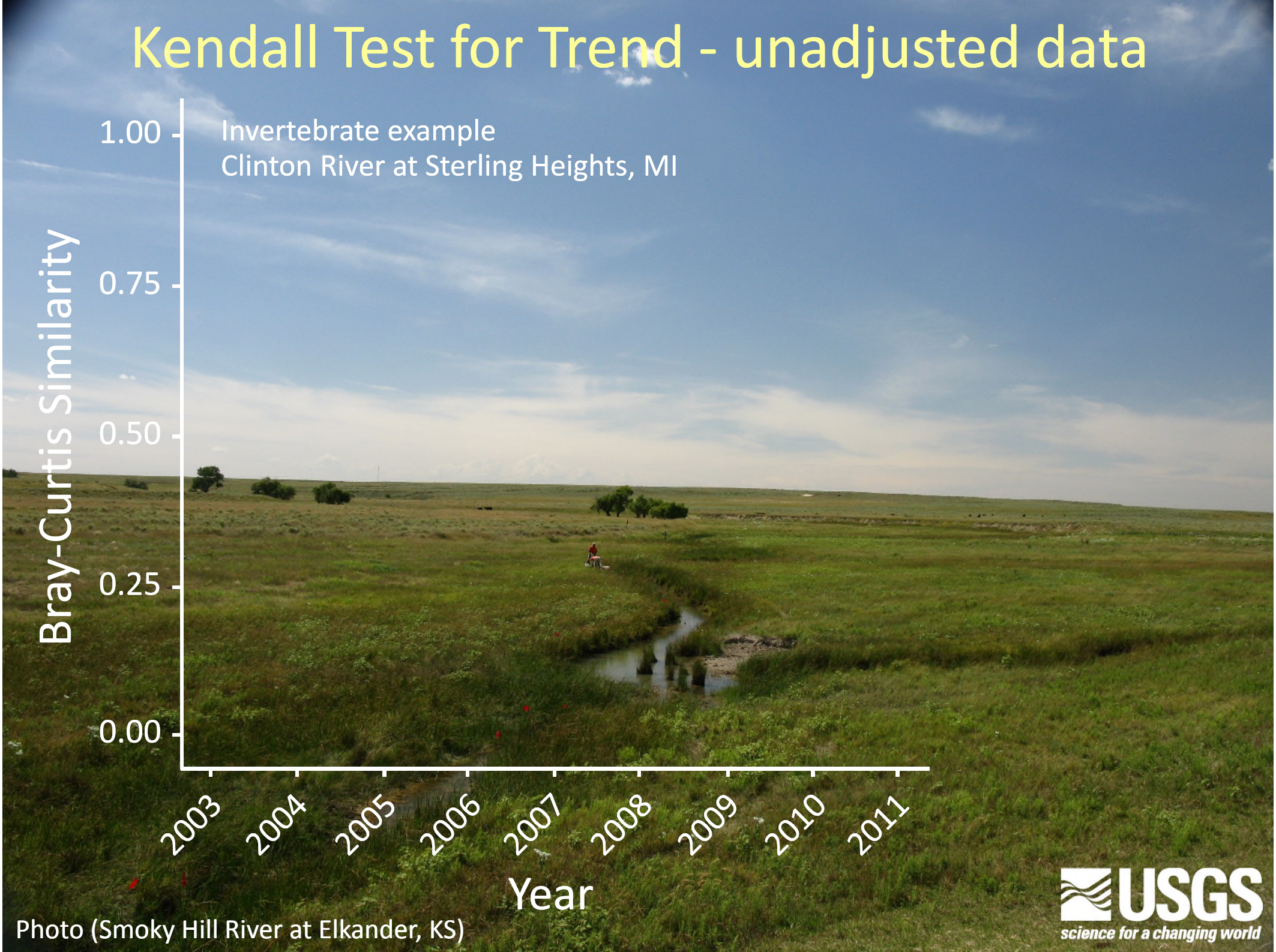
Kendall Test for Trend - unadjusted data



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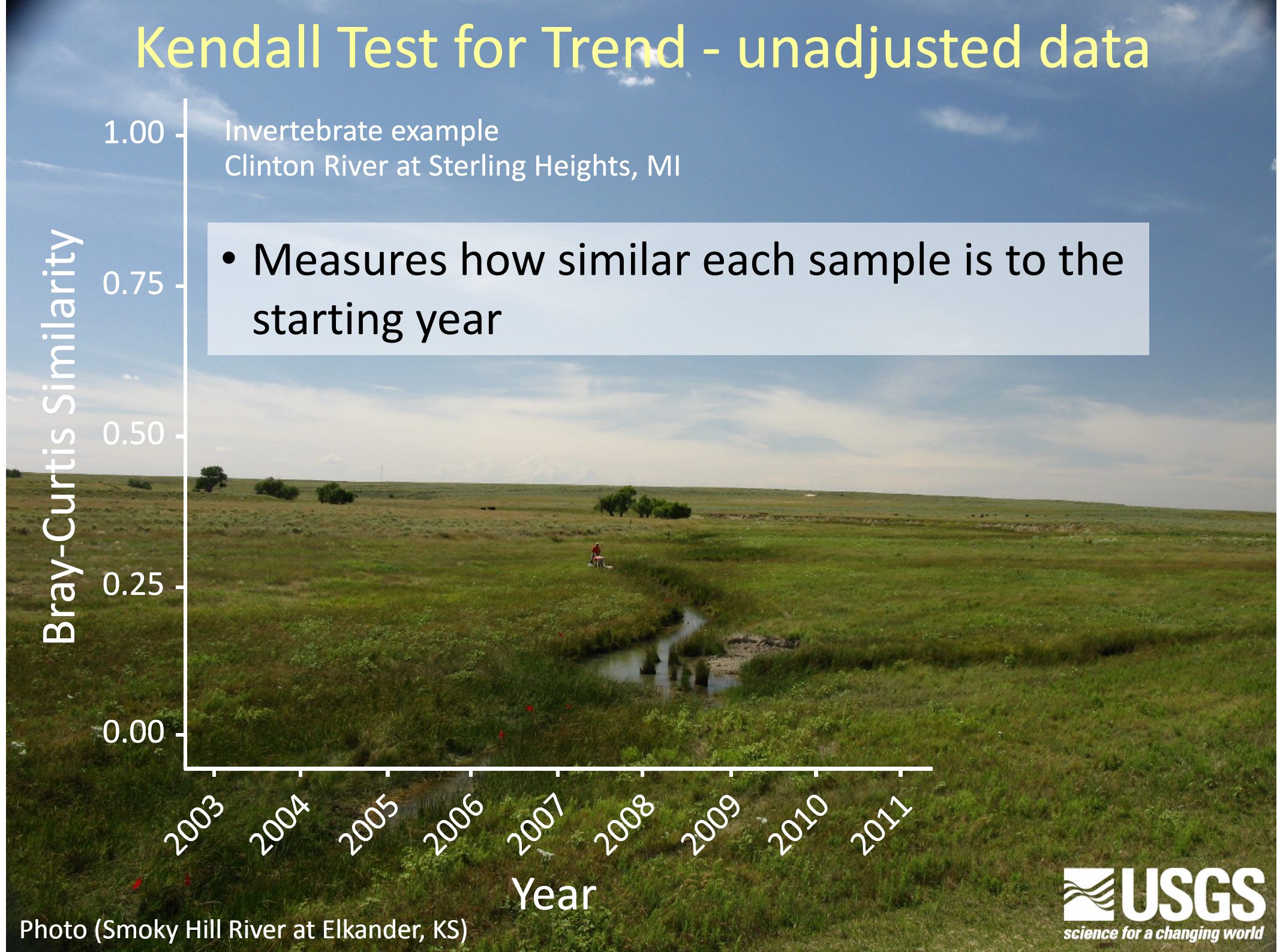

- Measures how similar each sample is to the starting year

Photo (Smoky Hill River at Elkander, KS)

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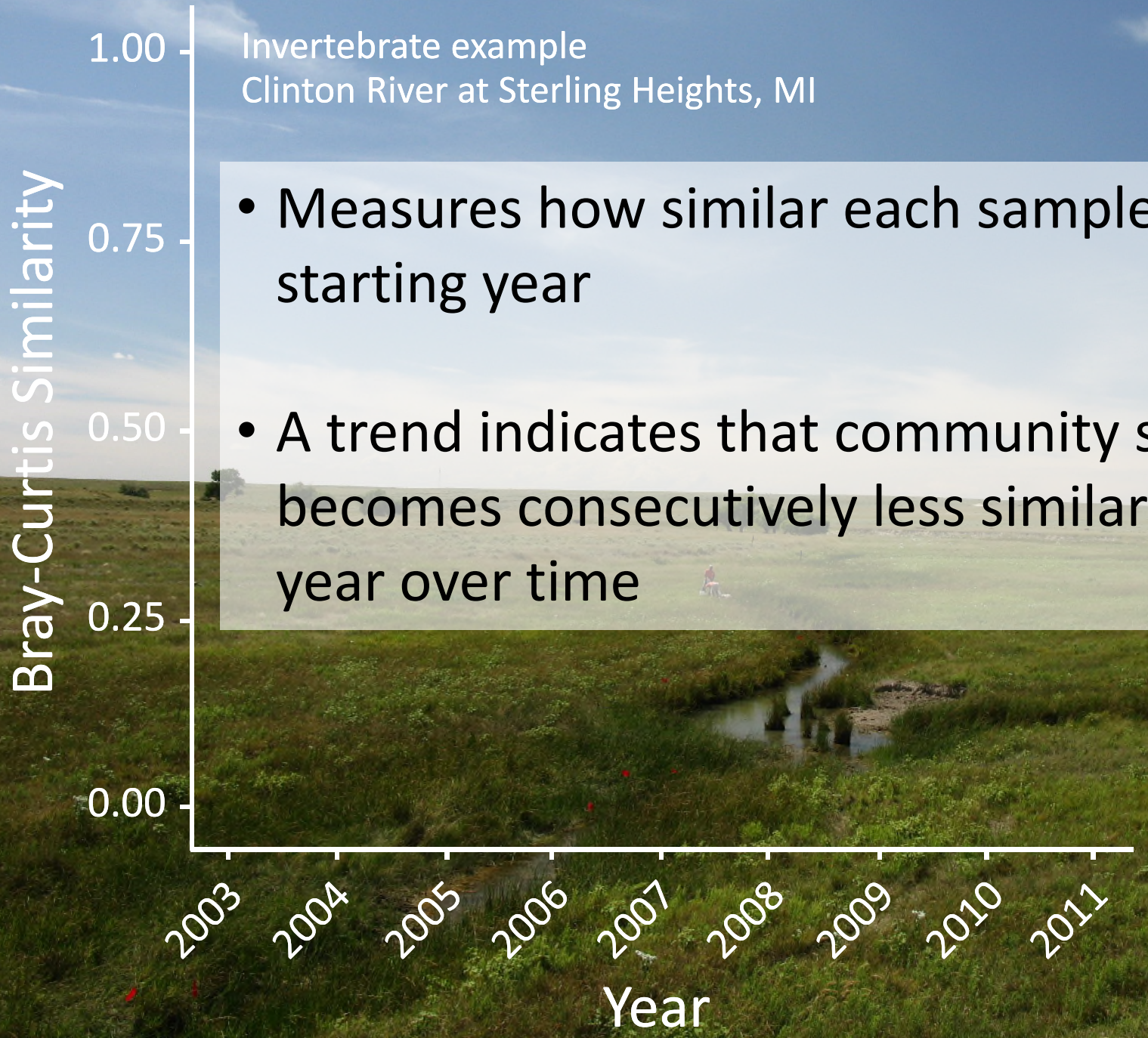
Kendall Test for Trend - unadjusted data



- Measures how similar each sample is to the starting year
- A trend indicates that community structure becomes consecutively less similar to the first year over time

Photo (Smoky Hill River at Elkander, KS)

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Kendall Test for Trend - unadjusted data

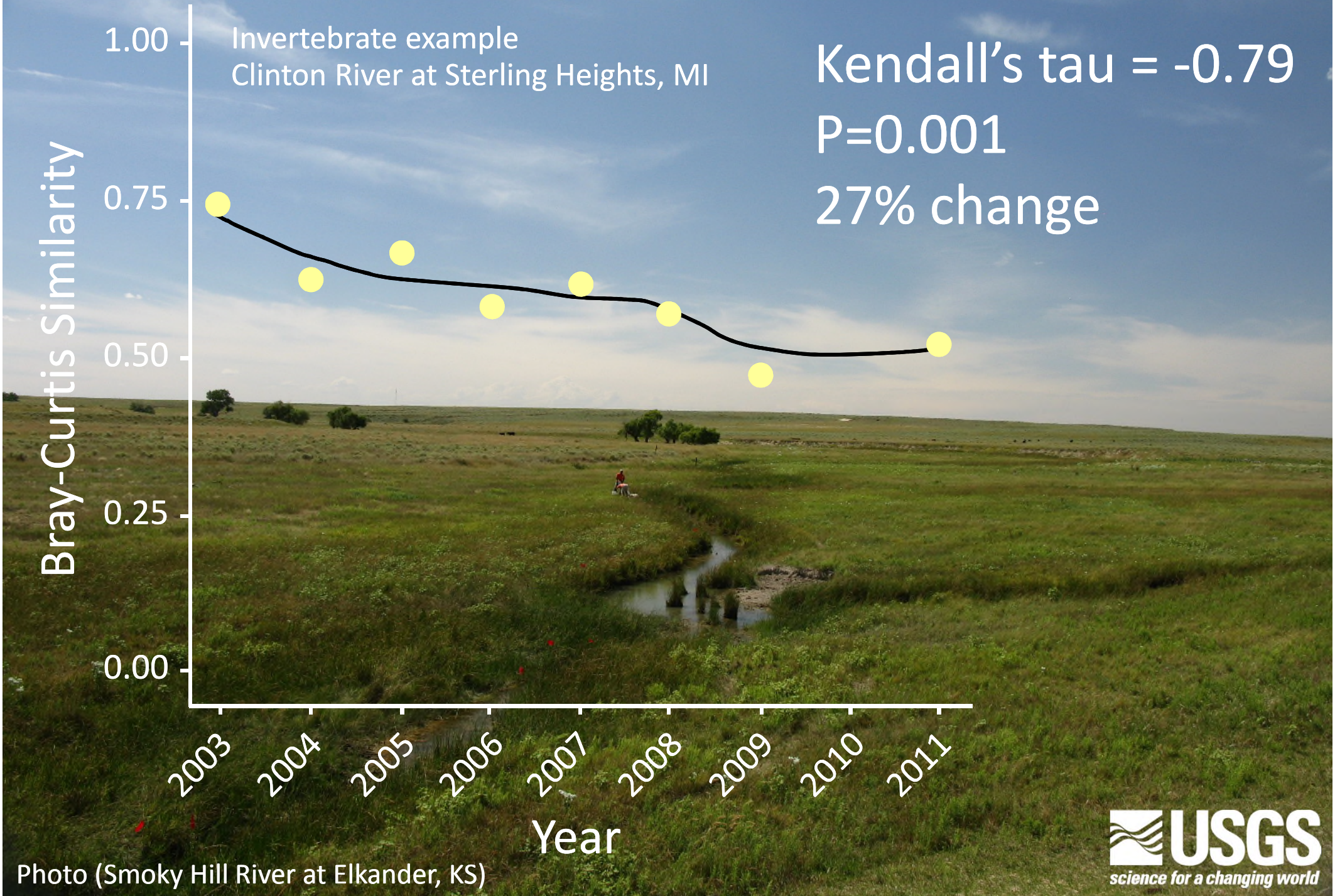

Photo (Smoky Hill River at Elkander, KS)

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Strongest Paired Correlation

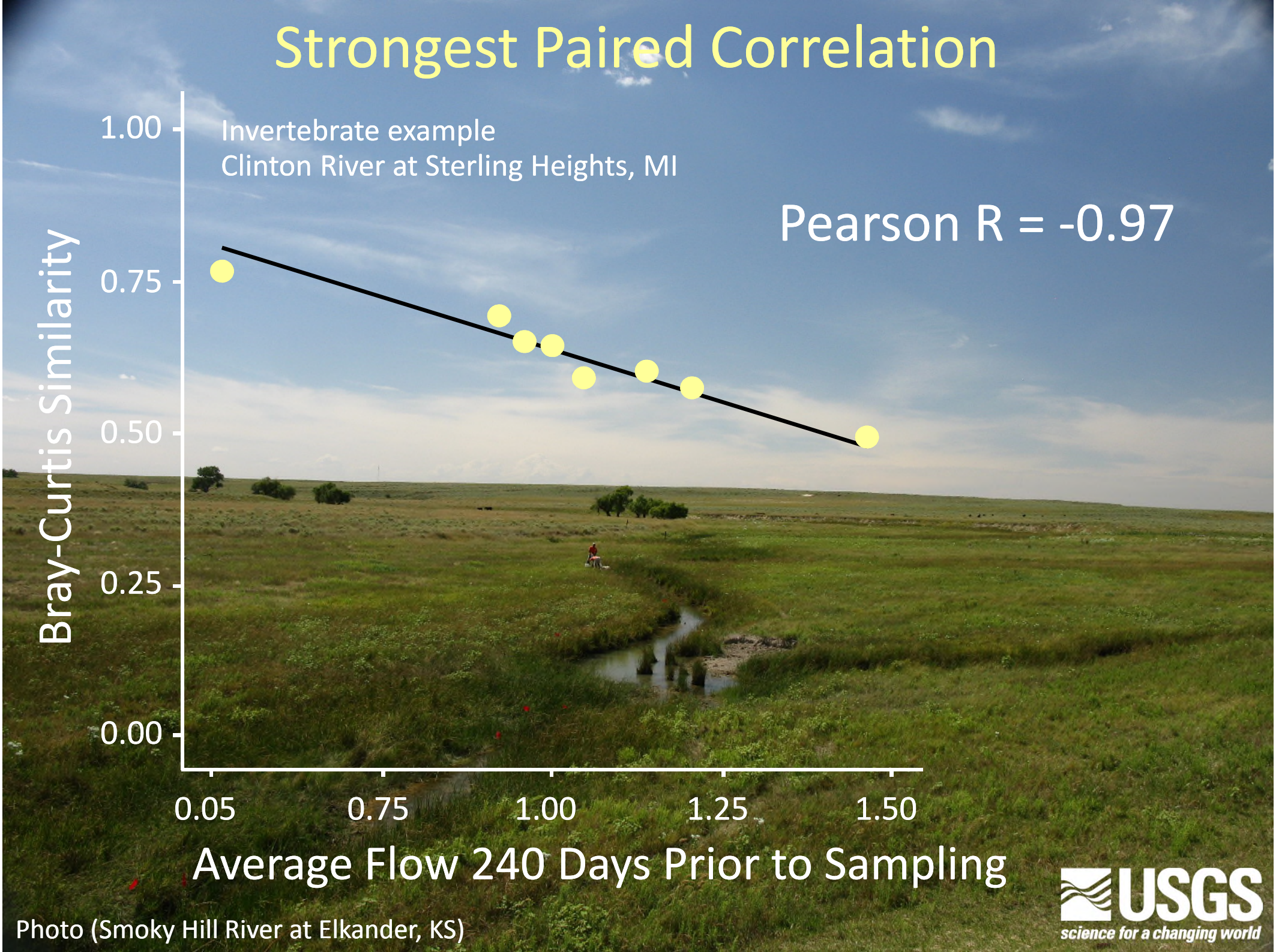

Photo (Smoky Hill River at Elkander, KS)

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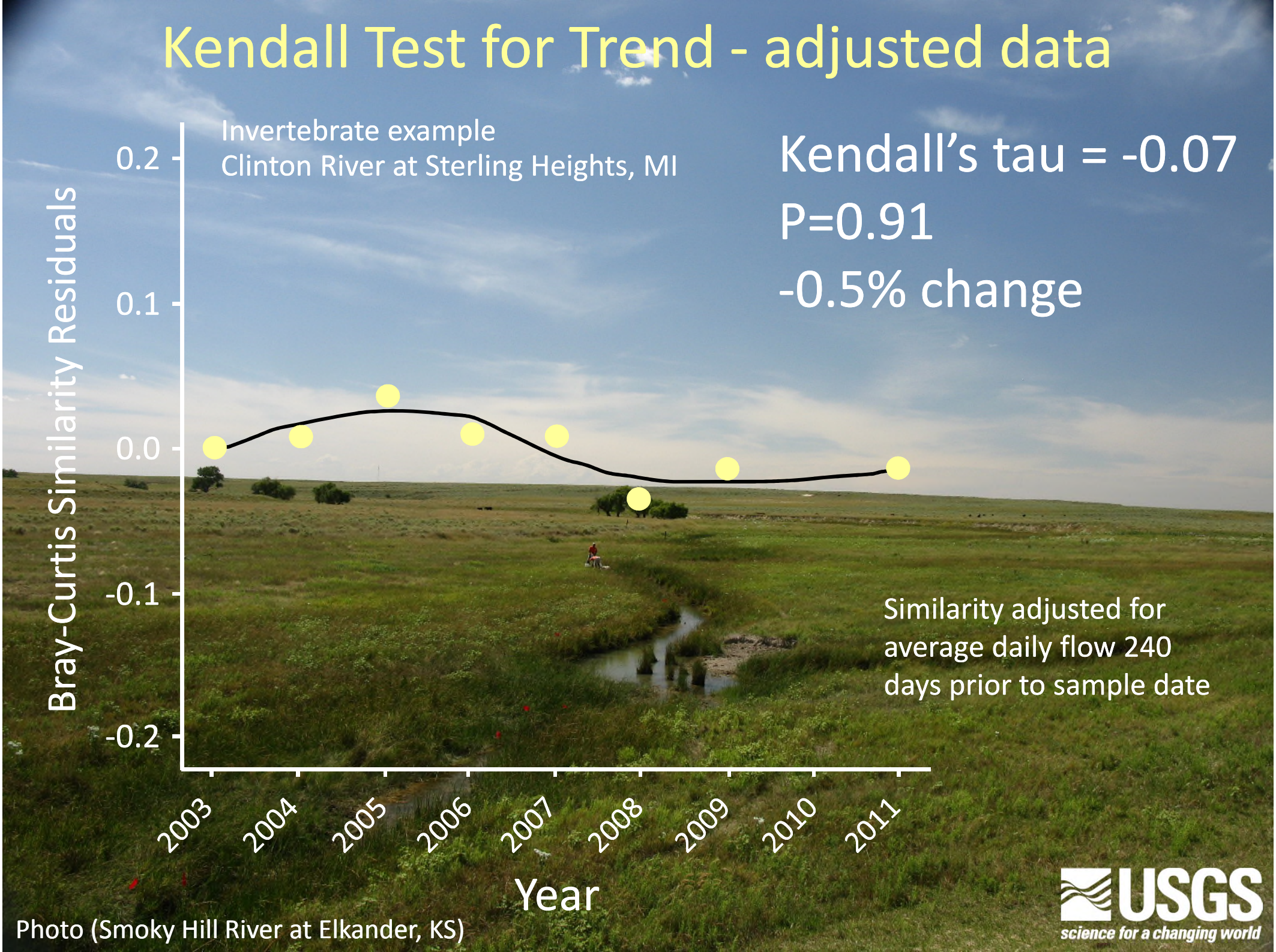
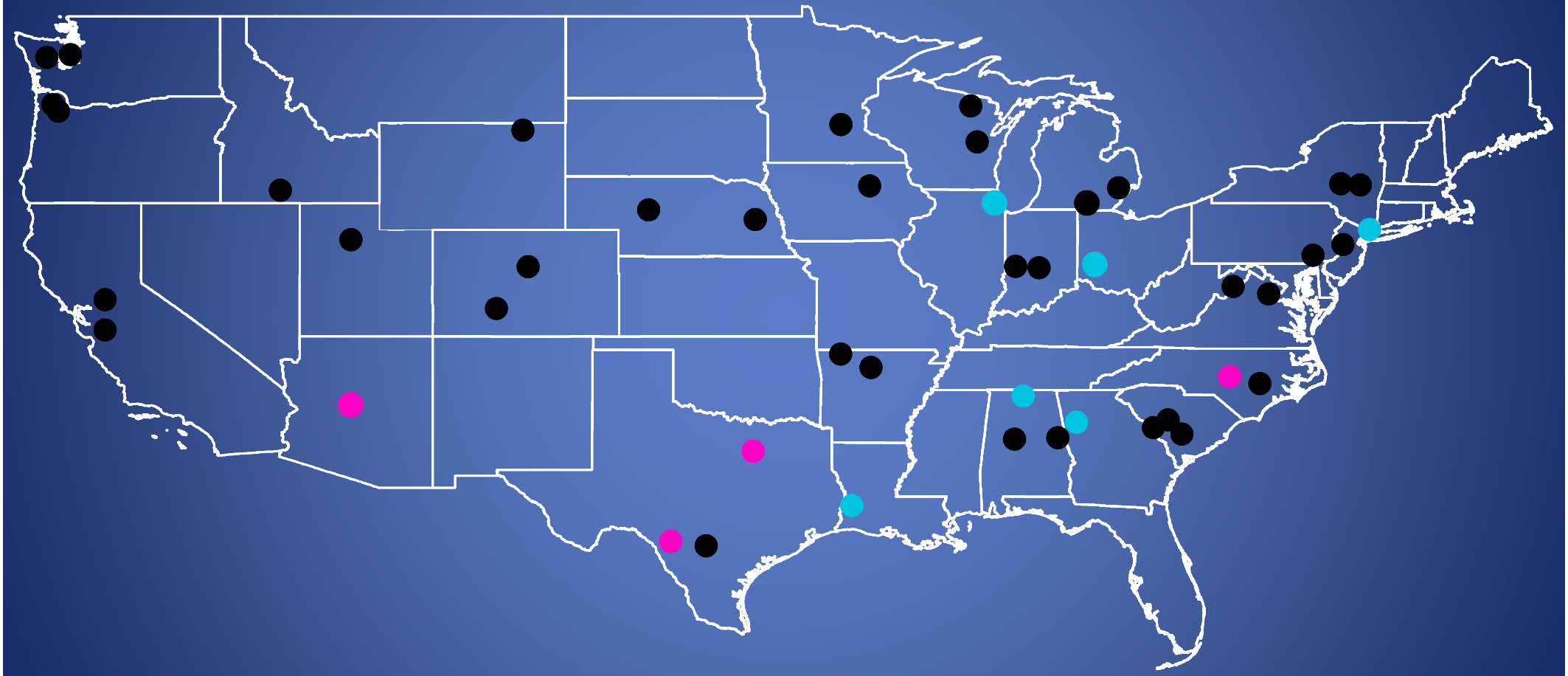
Kendall Test for Trend - adjusted data



Taxonomic Completeness O/E - Fish

- Trend period 2002 - 2012



- Highlighted trends have a 90% likelihood of occurring

decreased low likelihood of change increased

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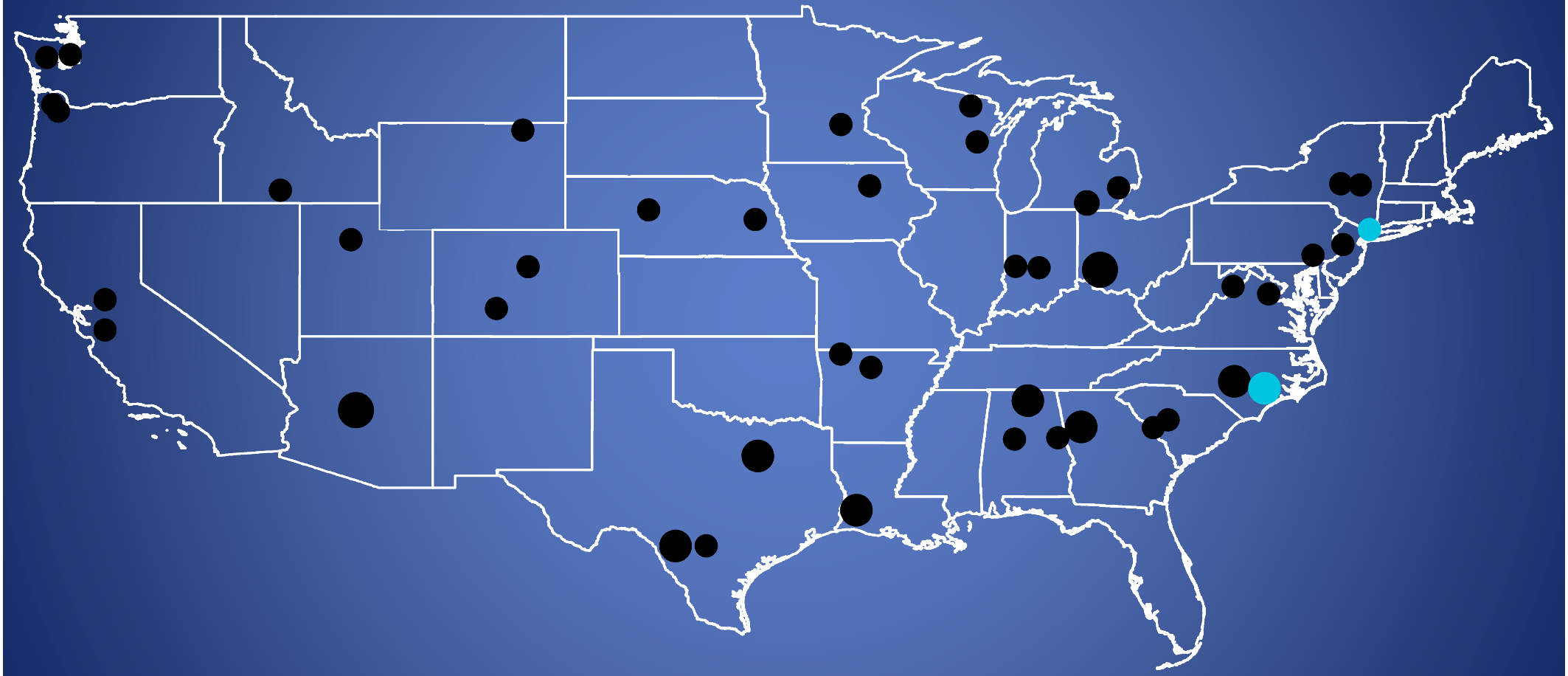
Adjusted Taxonomic Completeness O/E - Fish

- Trend period 2002 - 2012



- Highlighted trends have a 90% likelihood of occurring
- Larger points indicate change after adjustment

decreased low likelihood of change

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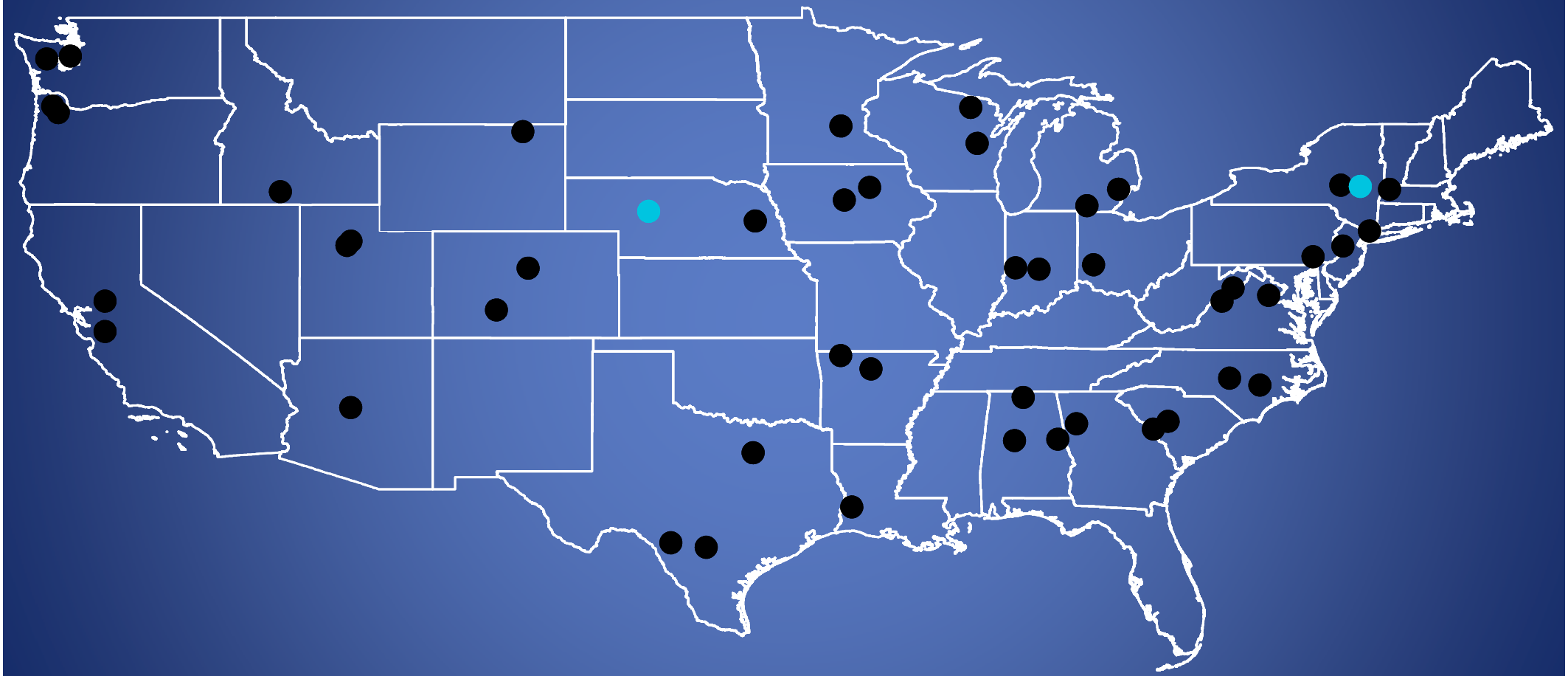
Invertebrate Taxa Richness

- Trend period 2002 - 2012



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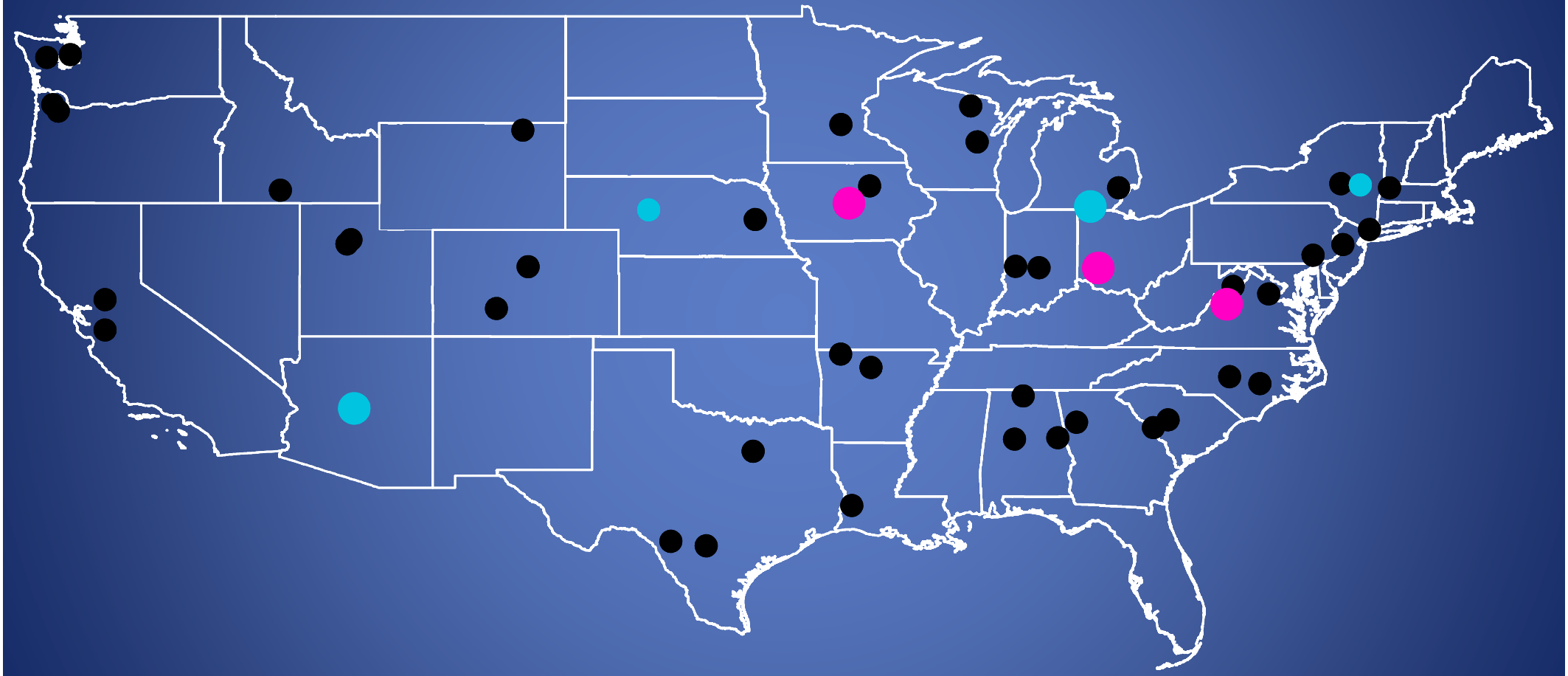
Adjusted Invertebrate Taxa Richness

- Trend period 2002 - 2012



- Highlighted trends have a 90% likelihood of occurring
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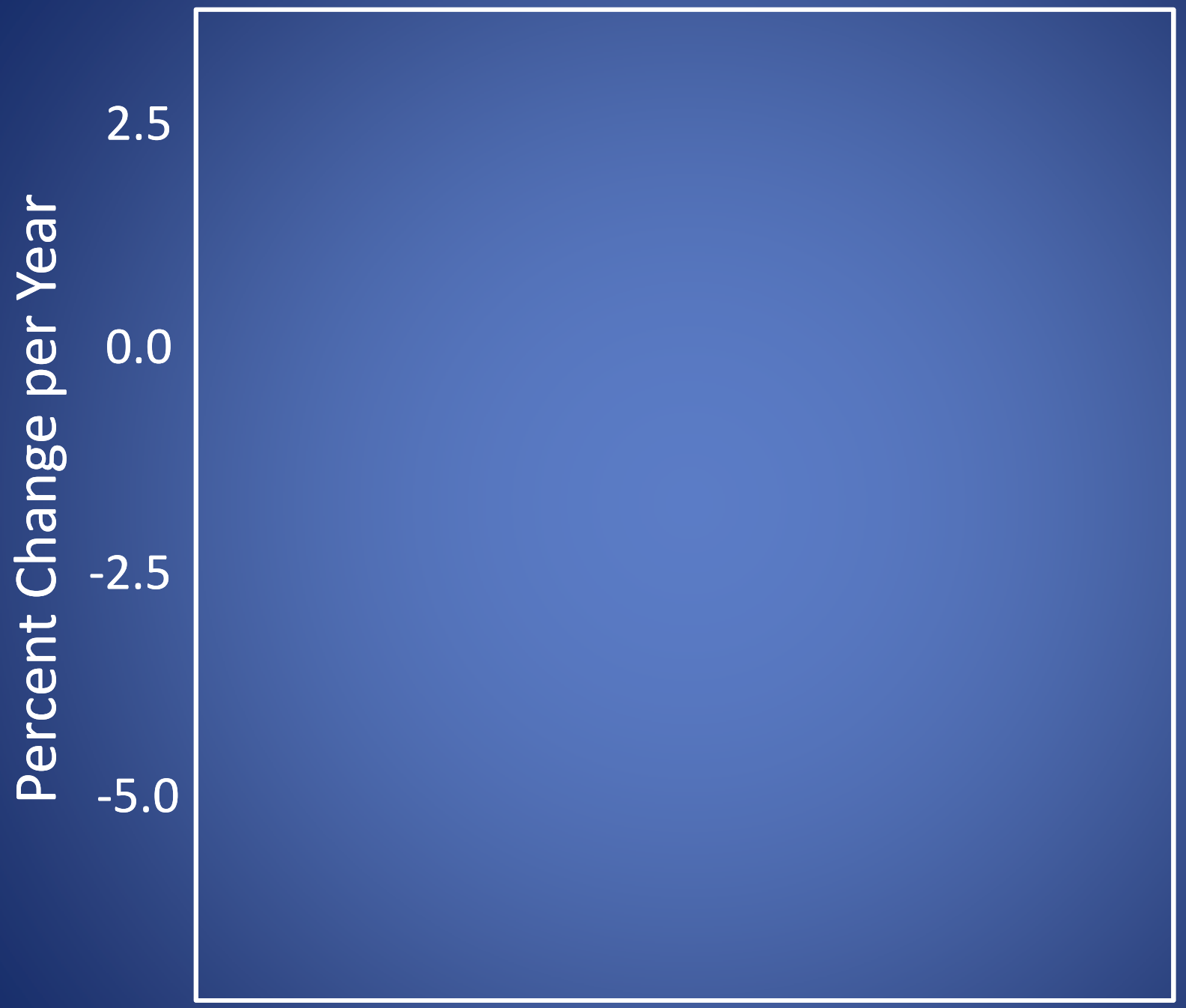
Effect of Climatic Variables



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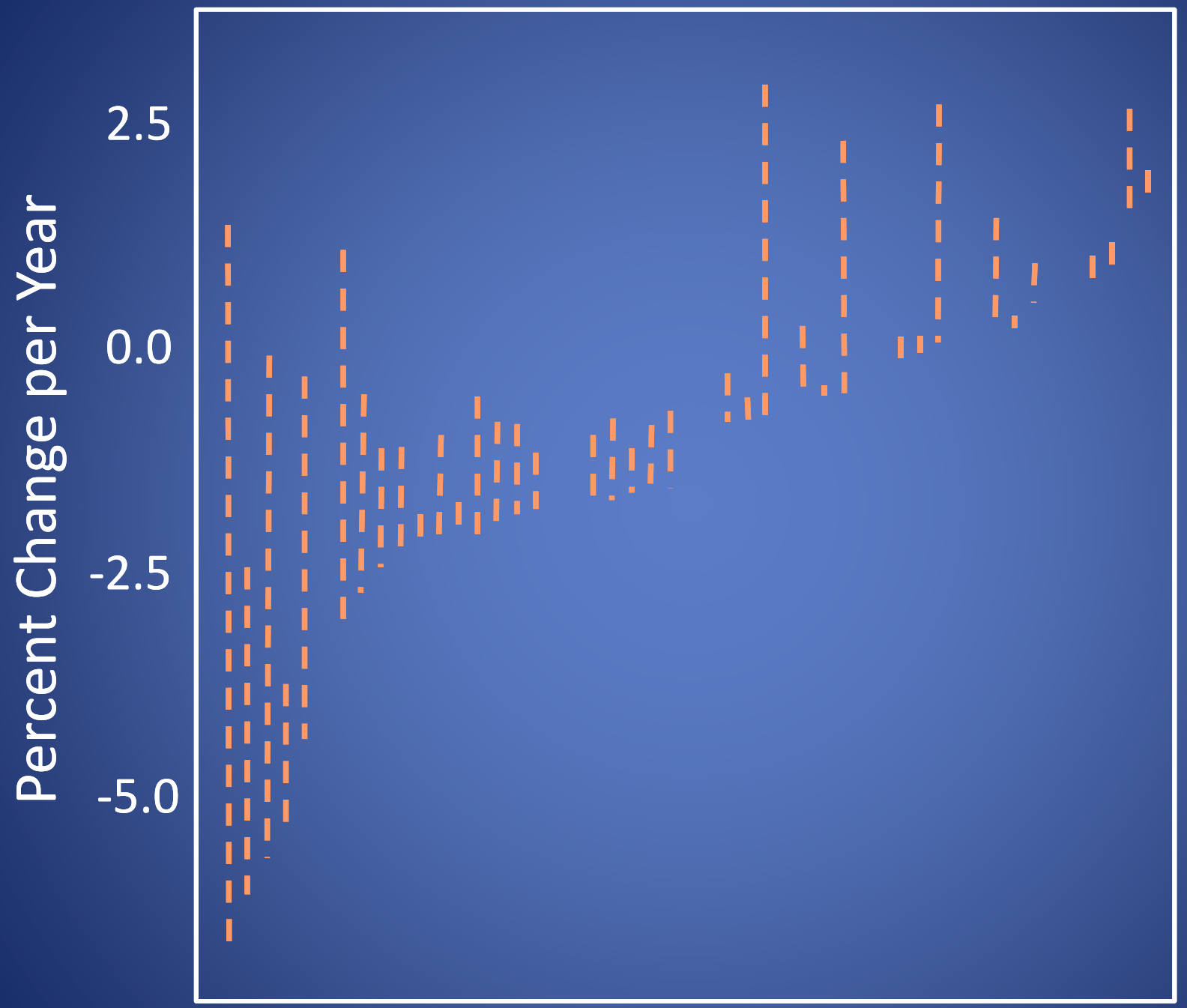

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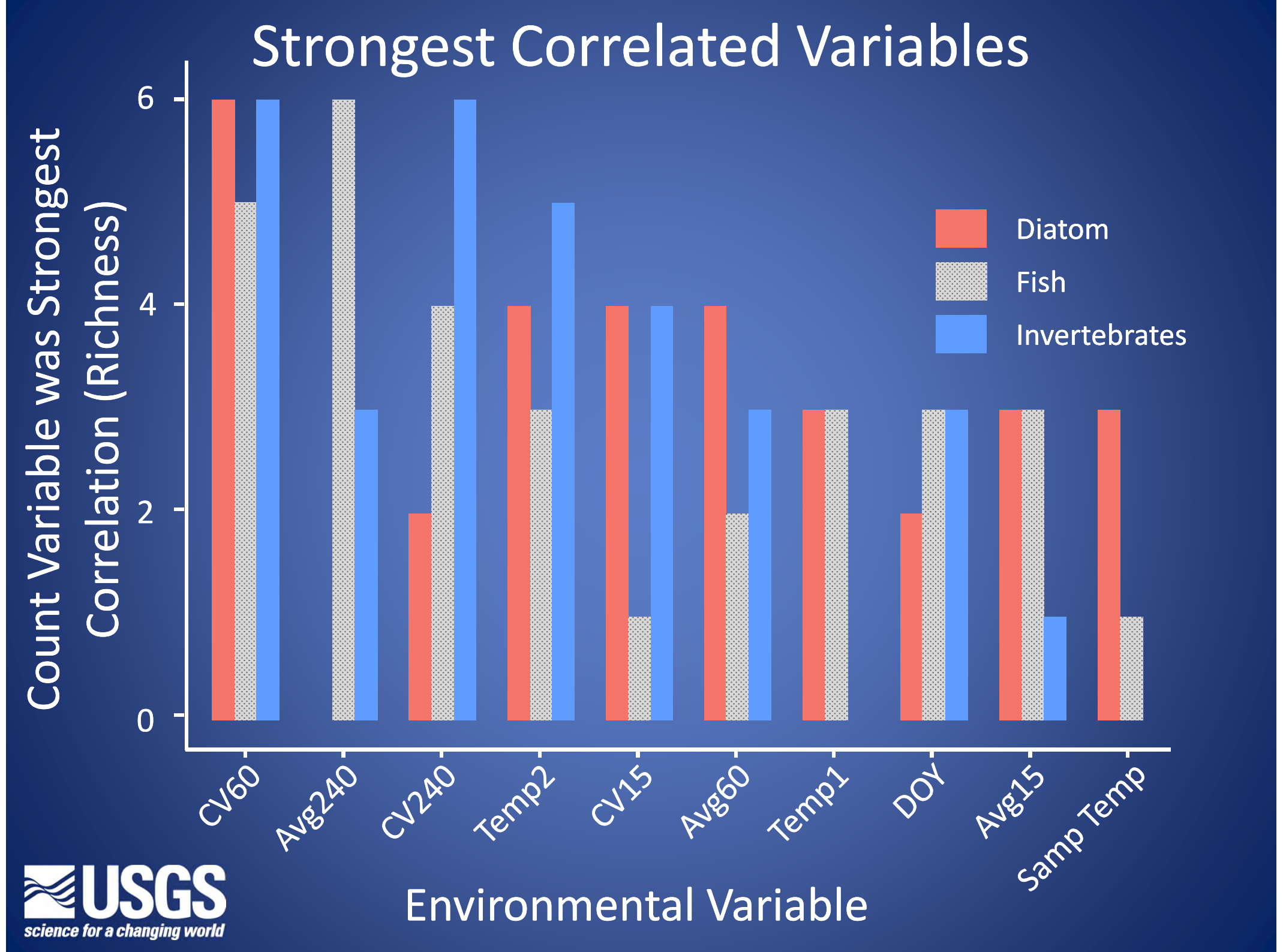
Strongest Correlated Variables
Count Variable was Strongest Correlation (Richness)
6
4
2
0
Diatom
Fish
Invertebrates
CV60
Avg240
CV240
Temp2
CV15
Avg60
Temp1
DOY
Avg15
Samp Temp
Environmental Variable
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At the End of the Day

- Accounting for antecedent conditions makes a difference

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At the End of the Day

- Accounting for antecedent conditions makes a difference
- Associations vary by site and assemblage
- Implications for interpreting bioassessment data

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Next Steps

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Next Steps

- Substitute precipitation for stream flow

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Next Steps

- Substitute precipitation for stream flow
- Test ideas with independent data

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Next Steps

- Substitute precipitation for stream flow
- Test ideas with independent data

- Provide biological relevance to QW trends

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Questions?

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- Daren Carlisle, James Falcone, Hank Johnson, Mike Meador, Jenny Murphy, Gretchen Oelsner, Karen Ryberg, Ted Stets, Melissa Riskin, Sarah Spaulding, Lori Sprague, Skip Vecchia

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